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WOODED MOUNTAINS AND NESTLING LAKES STILL HOLD THEIR LURE FOR VACATIONISTS SEEKING THE GREAT OUTDOORS

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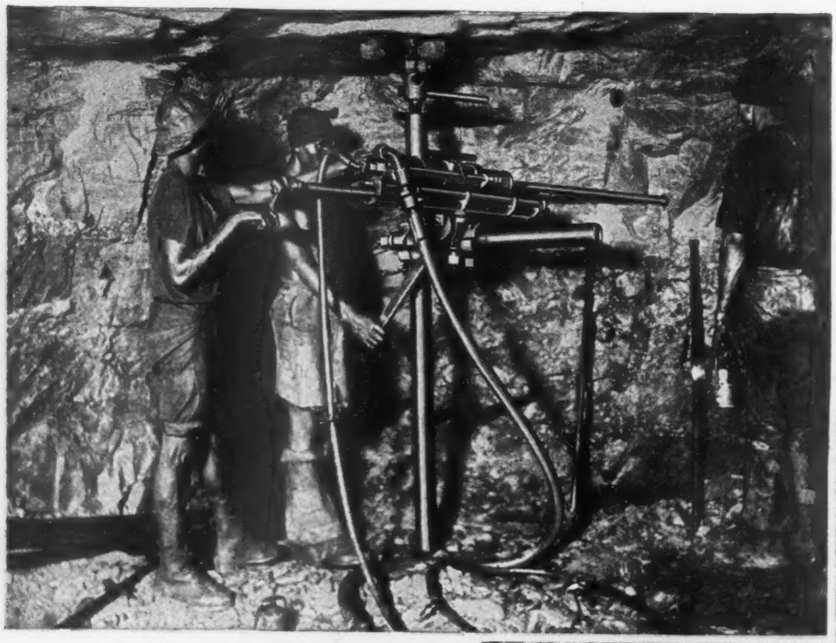
You'll Find I-R Rock Drills Wherever Ore Comes from the Ground



Two views underground in a South Africa gold mine, showing native miners operating I-R rock drills. A drifter is shown above and a "Jackhamer" at the right.

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As It Seems To Us

WE HOPE HE IS RIGHT

ACCORDING to Dr. JULIUS KLEIN, Assistant Secretary of The United States Department of Commerce, we are headed out of the slump and starting upward from a basis that will insure "an enduring stable prosperity". This is surely heartening news, and we earnestly trust that the pessimistic among us will ponder long and carefully this encouraging announcement. The only fly in the ointment, however, is that similar outgivings have issued intermittently for some time from Washington. Just the same, we hope Doctor KLEIN is right and that his conclusions are well founded.

The leading retail business is food, so this expert tells us; and the 497,715 stores thus engaged have annual sales totaling more than $11,000,000,000. Apparently, we almost live to eat. Next after the sale of foodstuffs come the activities of automobile sales establishments, filling stations, and garages serving the public. Those places do a yearly business amounting to $9,546,000,000. Doctor KLEIN does not analyze the automotive outlays, and we are, therefore, not able to say how much of the vast sum spent may properly be assigned to mere pleasure and convenience; but it is safe to say that relatively few of us realize how large this item figures in the aggregate retail trade of the country.

The same expert says: "Apparently, as a nation, we learn best in suffering—under the rod of adversity". The price of wisdom gained is never too much if a people actually profit by it in the end; and the same rule can be applied to the conditions that have contributed to the present depression from which, according to Doctor KLEIN, we are emerging. Can it be safely said that the rod has been applied to us sufficiently hard to stimulate our understanding and to keep us going henceforth in the path of economic rectitude? There are those among us that will remain skeptical on this point.

CROWS MAY SOLVE RIDDLE OF INSTINCT

FOUR-and-twenty blackbirds, baked in a pie, seemed more than enough to our juvenile minds to constitute a dainty dish to set before a king. Indeed, that number of blackbirds seemed to be truly multitudinous, but Dr. WILLIAM ROWAN, of the University of Alberta, cannot be so modestly satisfied. That professor of zoölogy is in the market for a thousand crows—preferably of the "nobler sex", so we are informed by the *New York Times*.

Somehow, the majority of us have quite failed to differentiate among crows; but we infer that the term nobler sex applies to the male of the species, and that Doctor ROWAN has centered on that sex because the male has a happy knack of finding his way home no matter how much he may be befuddled. Doctor ROWAN is bent upon ascertaining, to his own satisfaction, whether or not certain acts attributed to instinct are not, in fact, due to seasonal changes that take place in the secretions of certain glands and prompt animal life to do things for self-protection that have the outward indications of anticipation. For example, the migration or flight northward as spring approaches, and the return southward as the coming of cold weather nears.

By subjecting birds to artificial light—thus lengthening in effect the winter days, and by inducing greater measures of exercise, the glands in question are overstimulated. While in that condition, birds freed in cold weather will fly north to certain death instead of south to warmth and well-being. This is a blow to inherited promptings; but it is illuminating because it reveals in part how nature works in stimulating the urge commonly called instinct.

LAKE NEMI YIELDING GALLEYS OF IMPERIAL ROME

WHAT did CALIGULA do aboard the reputedly sumptuous galleys that once floated upon the waters of Lake Nemi?

As is well known those craft lay for centuries on the bottom of that picturesque lake in the heart of the Alban Hills; and intermittently during several hundreds of years efforts were made either to bring those sunken vessels to the surface or to recover some of the art treasures supposed to be still aboard or within their submerged hulls.

The majority of the efforts were, however, largely destructive, because operations were conducted from the surface and were designed to hook on to the craft and to raise them by main force—the force spending itself in tearing away timbers and in destroying different parts of the wrecks. These essays, failing to accomplish the desired end, were abandoned; and three years ago work was started on pumping the lake dry so that the galleys could be recovered by building around them supporting structures that would permit of hauling the ancient vessels high up on the lake shore. The complete unwatering of the lake will require another year or so.

While the disclosures to date have furnished no information about CALIGULA's life aboard those barges, still the craft, themselves, have revealed how amazingly far the Romans were advanced in the art of marine architecture. The galleys were modeled on a scale that would have been deemed magnificent during the period of the many gunned wooden line-of-battleship; and the Roman engineers resorted to the use of watertight bulkheads that made CALIGULA's galleys virtually unsinkable. Contrary to the long prevailing opinion that the vessels were the scenes of questionable orgies, there seems some warrant now for the belief that they were identified with religious observances. No matter what was their function, CALIGULA's galleys prove that their constructors were master shipbuilders and could have taught men in the same calling who followed centuries later.

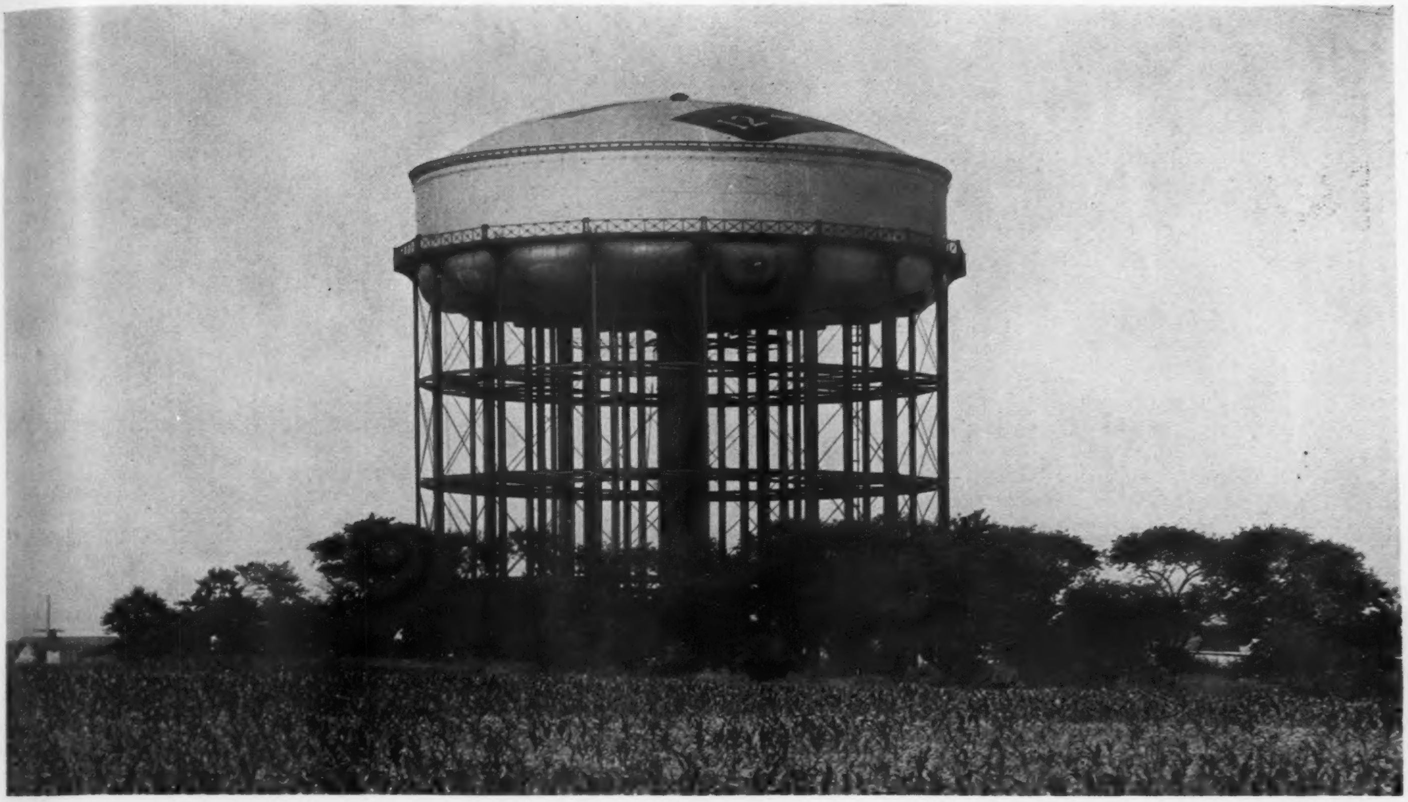
SHALL THE YORKTOWN PAGEANT BE DENATURED

MORE than once have we heard that an egg without salt is a perfect example of insipidity; and we all know how flat a Fourth of July would be without fireworks. How, then, will it be becomingly possible to celebrate the restoration of Yorktown, Va., and what Yorktown represents in the history of the United States without making it apparent that the whole occasion revolves around the one hundred and fiftieth anniversary of the surrender of Lord CORNWALLIS's army to General WASHINGTON and the allied troops of France and America?

The daily press and a number of the Sunday papers have discussed at some length the proposal made by certain persons of pronounced delicacy of feeling that the projected pageant at Yorktown in October shall have nothing in the way of a reminder of the surrender that would be likely to offend the sensibilities of any representatives of the nation that then suffered defeat. We had hoped that all feelings of resentment might have died long ere this and that the English speaking peoples as a whole had come to recognize the event as a turning point in the national lives of Great Britain and the United States that has been greatly for their common good.

Out in Centralia, Wash., they do things in a whole-hearted way—in the vernacular, "going the limit". In that community they celebrate annually by having what is known as the Southwest Washington Pioneers' Picnic. This festivity takes place yearly in the first half of August. To make the occasion typical of distant days, a city ordinance was passed requiring the males of the region to go unshaven for a specific time before the picnic in order that they may glory in the hirsute abundance of earlier days. Recently, the men who rebelled and used razors and scented powder were rounded up by a vigilance committee and made to do time in the stocks where they were exposed to "public shame".

Night view of Indiana's World War Memorial Plaza, in Indianapolis, which, when completed, will represent an outlay of $15,000,000.



Unique Water Tank for Indianapolis Suburb

This Form of Water Tank Has Much to Commend It and Is an Effective Means in Reducing Operating Costs

By S. G. ROBERTS

THE Indianapolis Water Company at Indianapolis, Ind., has just added a unique feature to its water-supply system. It now has in service an elevated tank capable of holding 1,500,000 gallons—the third one of its particular design in the United States.

People that have only to operate a faucet or to open a valve to get all the water they desire seldom know how much has to be done not only to make that convenience available but to maintain the supply day and night the year round. The availability of a plenty of water concerns even more than the comfort of the user—without that water there would be no safeguard against the possible ravages of fire. The disposition of the average consumer is to take his water supply for granted, to find fault when there is any momentary interruption in the flow, and to berate the constituted authorities when the bill or the tax for the water used comes in. The latter is all too frequently objected to on the score that it is excessive—such being the lack of understanding, not to mention lack of gratitude, on the part of the run of individuals benefited.

We have purposely touched upon this aspect of a matter that has to do with the maintenance of the health and the security of most up-to-date communities so that the reader may be better fitted to evaluate how engineers have to plan in order that water can be had in sufficient quantity at all hours and at a cost that will not be a burden. The problem of furnishing a sizable city with water for all essential purposes is a complex one, because—apart from the availability of an ample source of supply—there are topographical, hydraulic, and power factors that must receive due weight. Assuming that there is enough water always at hand, that water will not flow unaided to all parts of the distributing system. Water will not flow uphill; and to deliver it to points above the source some means of pumping must be employed. That pumping calls for the expenditure of power; and power, in its turn, costs money. The greater the head against which the water must be forced uphill the greater the outlay in the form of mechanical energy; and the pressure developed in the mains while doing this induces frictional resistance that must be overcome, thus adding to the amount of power required to perform the service.

From an engineering viewpoint it is highly desirable to arrange distribution so that water can be stored in elevated reservoirs or tanks during the period of slack demand and then used to feed water into the mains by gravity during the peak-load hours. Such an arrangement would make it possible to utilize the pumping plant without overloading it at any time, it would avoid high pressures in the distributing system, and it would materially lower operating costs—lessening to that extent the charge upon the ratepayer or taxpayer, as the case might be. These several considerations have been clearly stated by Mr. W. C. Mabee, chief engineer of the Indianapolis Water Company, in a paper read by him a short while ago before the American Waterworks Association. Mr. Mabee dwelt at some length upon the advantages of elevated storage. We cannot here quote that authority *in extenso*, but we shall abstract from his illuminating paper most of the outstanding points raised by him.

Elevated storage, as he states, is becoming generally recognized as a valuable adjunct to the existing arterial system of a water supply requiring the use of a pumping plant. The advantage it offers is outstanding in growing communities calling for pipe-line extensions into new sections; and this is especially true where such developments are made on ground well above the general level of the established city. To supply these higher and outlying districts, the pumping plant and the mains are often overtaxed. Accordingly, safety of operation and economy will result if elevated storage is provided. Furthermore, there is a saving in first cost.

After elevated storage is provided, part at least of the pumping equipment can be relieved of continual service—becoming re-

serve pumping capacity; and the mains, instead of being overloaded, will be found of ample capacity. These changes increase the dependability of station operation and insure a greater factor of safety. That is to say, this desirable status is brought about by utilizing the pumps during off-peak hours to refill storage reservoirs or tanks, in this way avoiding excessively high pumping rates during the on-peak hours. The procedure, where reservoirs or tanks are used, is to fill these storage facilities in the night-time and to draw from them during the daytime, thus equalizing the pumpage rate throughout the 24 hours. It is also possible, in this manner, to maintain more nearly constant pressures and, therefore, to improve the water service during the hours of heaviest demand.

The eastern section of Indianapolis, with a population of 50,000, has heretofore been supplied with water by the High Service Station—the pressure ranging from 85 to 130 pounds per square inch. When the summer load reached a point beyond the capacity of that station to supply satisfactory service at the extremities of the distributing system, then booster stations were called upon to help out. Last year the booster stations were operated during 123 days, and their output ranged from 6,000,000 gallons to 16,000,000 gallons *per diem*. It was this situation that induced the Indianapolis Water Company to construct in the section of the city mentioned the elevated tank that has a capacity of 1,500,000 gallons. Assuming a summer demand equal to that of last year, the tank will play its part so effectually that the boosters should not be operated more than twenty hours over a period of thirteen days, and then at nominal rates only. In short, this tank storage will reduce the peak pumpage rates one-half by supplying the other half of the peak demand.

In summing up the benefits resulting from the use of tanks. Mr. Mabee cites the following outstanding gains:

"Elevated storage, advantageously placed, affords an economical solution of many distribution problems.

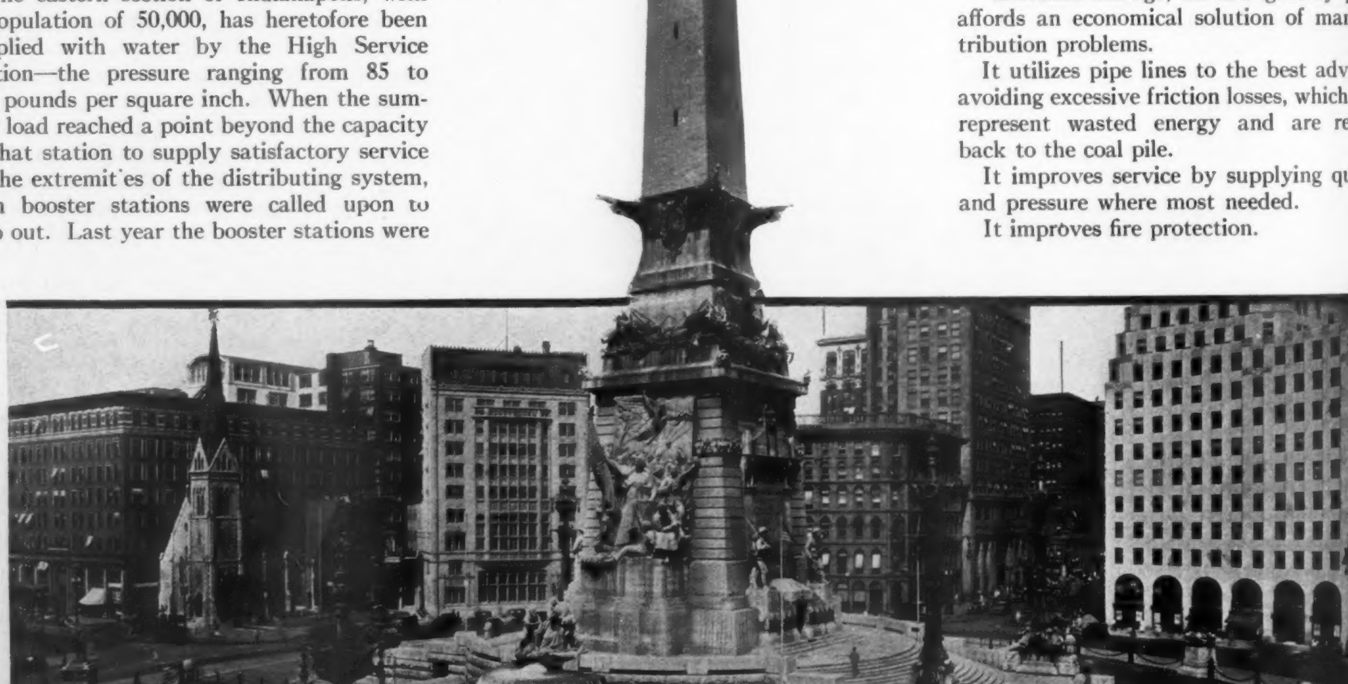
It utilizes pipe lines to the best advantage avoiding excessive friction losses, which losses represent wasted energy and are reflected back to the coal pile.

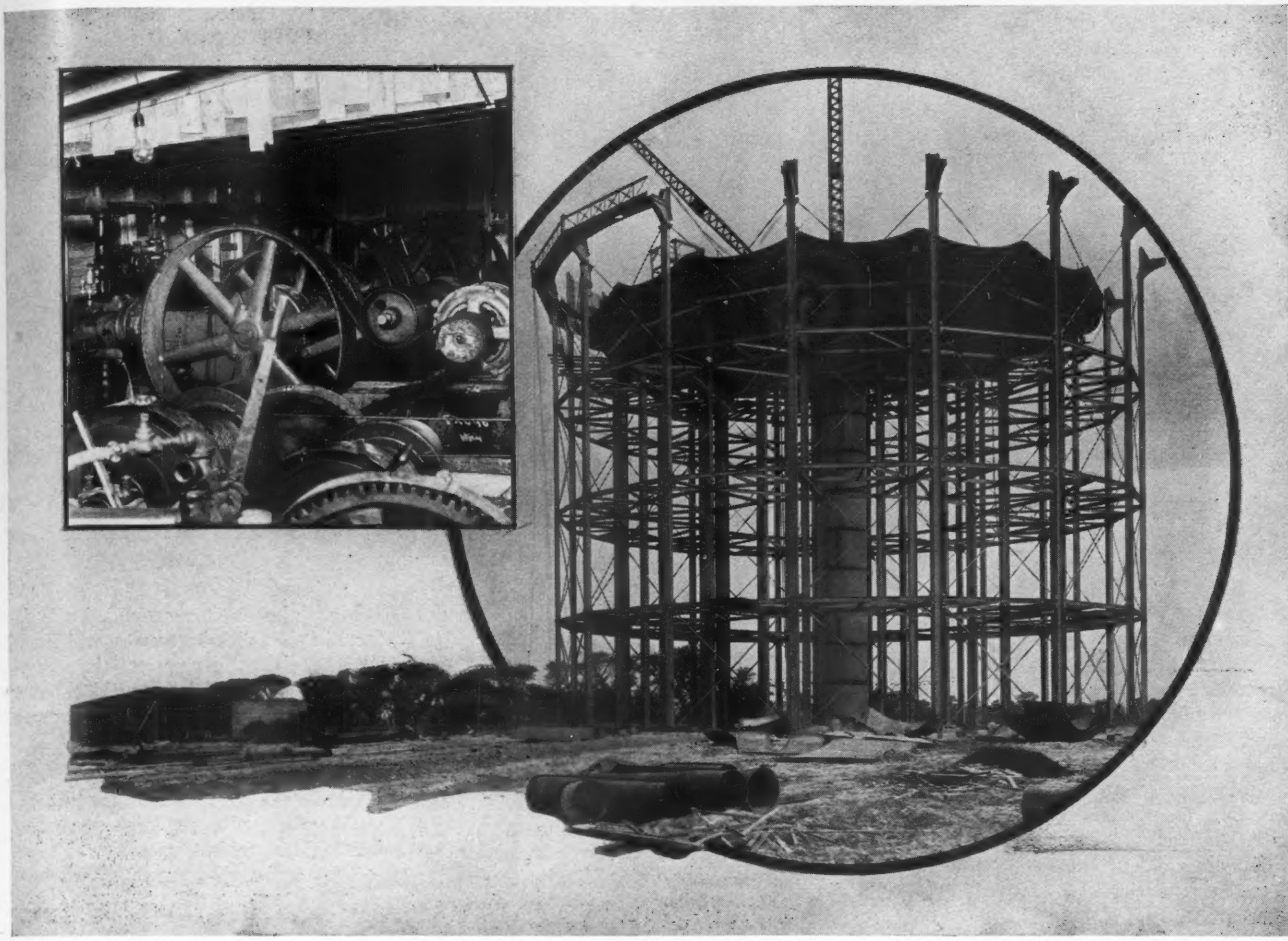
It improves service by supplying quantity and pressure where most needed.

It improves fire protection.

Looking north on Meridian Street from top of World War Memorial Plaza.

Indiana's towering monument to her soldiers and sailors in the World War.





Left—Some of the compressors that supplied air to the pneumatic tools used in assembling the storage tank. Right—The Irvington radial-cone-bottom tank in course of construction.

Its effect on plants already equipped is to increase the safety factor by releasing equipment for reserve pumping capacity.

It postpones the installation of additional plant equipment devoted to the distribution of water."

The elevated storage tank erected in Irvington, the Indianapolis suburb, by the Chicago Bridge & Iron Works is technically known as the radial-cone-bottom type, and, like two others previously built for service in Brooklyn, N. Y., and Sandusky, Ohio, was developed to furnish large capacity with a relatively small variation between the uppermost and the lowest water levels. As can be readily understood, it is desirable to have a minimum variation in water level and its attendant hydrostatic pressure, especially when tanks of this kind are used to supply municipalities. The total variation between the uppermost and the lowermost water lines in the Irvington tank of the Indianapolis Water Company is but 25 feet, while its diameter is 104 feet. The bottom of the tank is 72 feet above the ground. More than 550 tons of steel were required for its construction; and in assembling it nearly 100,000 rivets were driven—the rivets varying in size from $\frac{7}{8}$ inch to 1 inch. The first steel was delivered at the site on April 7, 1931, and the tank was completed and ready to receive water on June 25, following. This was a rapid performance. Compressed air for operating riveting hammers and a Size D6UL "Utility" hoist was furnished by one 160-cubic-foot and three 325-cubic-foot Ingersoll-Rand compressors.

SIGNAL TOWER MOVED WITHOUT STOPPING SERVICE

SHIFTING a large electro-pneumatic signal tower a matter of 35 feet without interrupting train service for an instant was an important phase of the work involved in the reconstruction and the enlargement of the yard of the North Station passenger terminal in Boston, Mass., of the Boston & Maine Railroad. The tower is three stories high, and in it are brought to a focus 640 electric wires and cables and three pipe lines, one each for hot water, cold water, and compressed air.

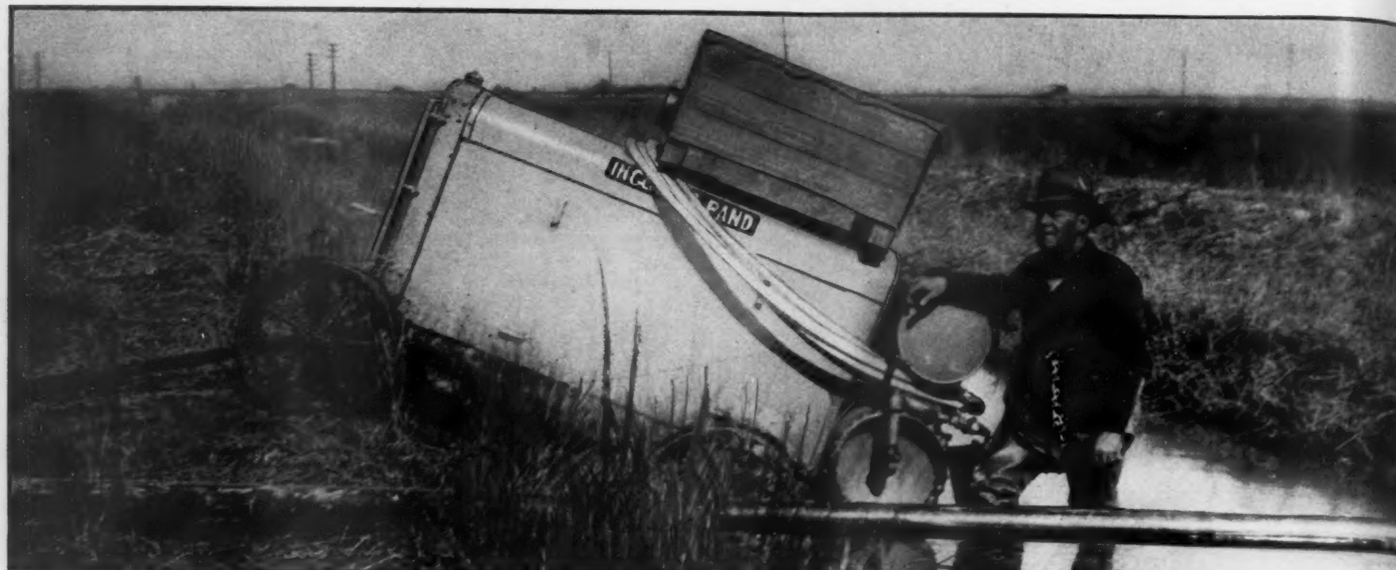
To each of the hundreds of connecting lines were added 35 feet of slack. While this was being done the building movers made their preparations, which took four days. The actual time required to effect the change in site was but $3\frac{1}{2}$ hours; and so smoothly did the six men with a hand winch do their work that the operators at their posts were hardly aware of the fact that they and their tower with its appendages were being relocated. The structure was transported and set on its new foundation without the least disturbance in the normal functioning of the switches and signals which control daily the movement of about 350 trains.

FINGER OF LIGHT MARKS PASSING HOURS AFTER NIGHTFALL

A TIMEPIECE that will indicate the passing of the hours throughout the night without a disturbing sound is being built by the municipality of Guayaquil, Ecuador. This unusual timepiece is of gigantic proportions, and will operate on the principle of the sun dial. Instead of telling the time by the casting of a shadow, however, a finger of light will mark the hours.

Guayaquil is engaged in beautifying her waterfront by a system of parks, in the center of which is being erected a Moorish tower to be topped by a 24-inch beacon with a 1,000-watt lamp. This searchlight will serve the dual purpose of guiding aviators and of providing the illumination necessary for the functioning of the silent timekeeper.

The beacon will be mounted so as to make one complete revolution every twelve hours. This will be effected by the impulses from a telechron clock, which impulses will be transmitted to a solenoid-operated turning mechanism every five seconds through the medium of a standard traffic timer. The ray of light, as it makes its precisely timed revolution, will illuminate specific landmarks of Guayaquil at the same moment throughout the period of darkness, thus indicating the hours the night long to all those that may be awake.



Web-footed portable coming up out of one of the many ditches that had to be negotiated.

Web-Footed Portable

LAST January, at Gillis, La., the Texas Construction Company started the laying of a lateral gas line to Vinton, a town about 35 miles away—the route passing through the intermediate points of Lake Charles, Westlake, and Sulphur. Work on this project, which has since been finished, was considerably hampered by swamps and bogs that had to be negotiated frequently from the beginning to the end of the route. When but a few miles out of Gillis it was found necessary to mount all the equipment on skids and to employ four mules to haul it.

One unit of the equipment was an Ingersoll-Rand 5½x5-inch portable compressor which was used to test the line, section by section, upon completion. This, like the other machines, was often mired during the initial stages of the work. By the use of the skids it was possible to eliminate this difficulty in swampy ground; but those attachments proved to be but a partway solution when dry ground was reached. The skids therefore had to be put on and taken off repeatedly, depending upon the nature of the terrain: Much valuable time was thus wasted—in fact, it sometimes took a whole day to get from one test place to another.

Finally, R. L. Johnson of the Texas Construction Company conceived and tried another arrangement of skids. This turned out to be so satisfactory that the transportation troubles became a thing of the past. Mr. Johnson took a pair of 10-inch channel irons that had previously served as skids, and where they had been turned up at an angle of about 15° at the front he cut off part of the flanged sides and bent back the web until it was parallel to the main body of the iron. The flat surface was bolted to the front of the compressor frame. A stand was then made, and this was welded to the channel iron and bolted to the rear of the compressor frame.

When traveling over firm land, the new skids were normally about 4 inches above the ground so that they did not interfere with the rotating of the wheels nor in any way lessen the outfit's portability. In soft ground, however, where the compressor sank at times to a depth of 4 inches, the skids effectually took the load and prevented the machine from sinking further.

According to Mr. Johnson, the device gave excellent results over a period of months, as the unit did not become mired once after the skids were attached. The compressor was hauled across canals, rice fields, swamps, bogs, etc., without difficulty, and was taken wherever four mules could go. By this method of mounting it was possible to make a move in one or two hours that previously had taken a day or more.

Mr. Johnson has amplified the foregoi[ng] facts in the following verses, which add som[e]what to the colorfulness of the story. Ma[ni]festly, his sense of humor did not desert hi[m] despite the mud and water through which th[e] gas lateral had to be advanced:

"I have worked on lots of pipe lines
In places that are most remote;
But this Louisiana mud line
Is the one that gets my goat.

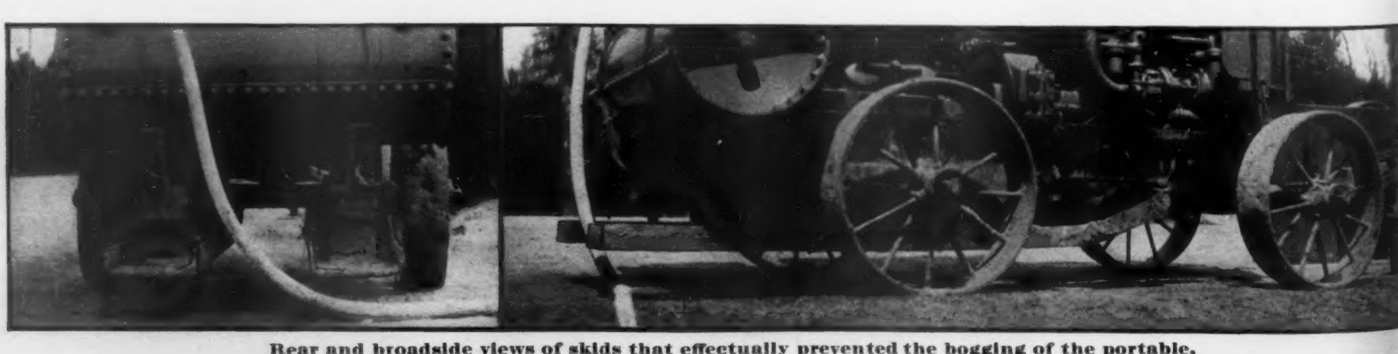
When you see a mud puddle wiggling,
It's just a workman out of luck,
And trying to reach the other side
By wading underneath the muck.

They take a hundred feet of cable
And tie the equipment to a tree,
So when they come to work next morning
They can find where it used to be.

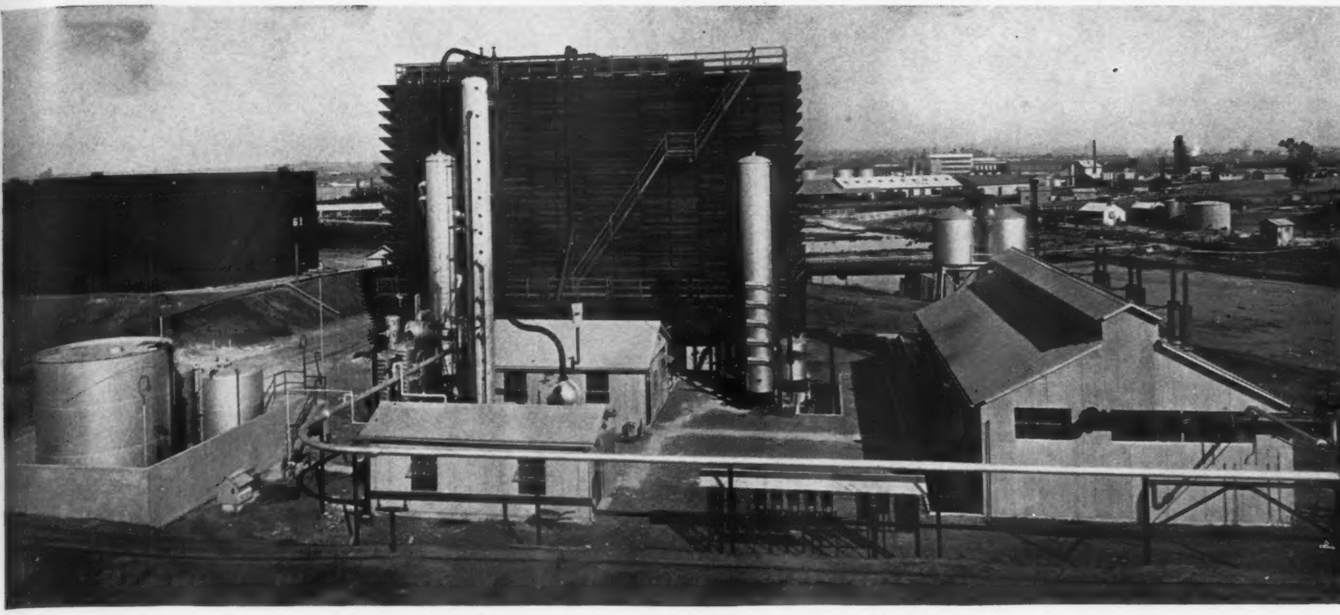
Another thing I can't understand
Is the disappearing right of way,
It seems to go bye-bye every night
And come back with the tide next day.

When the superintendent rides the line
He puts the paint horse astride the pipe
He knows from past experience
It's the only way to stay in sight.

It takes four mules and a lot of bull
To get anywhere in this bog;
And they have to put bells on the leaders
So they won't lose them in the fog."



Rear and broadside views of skids that effectually prevented the bogging of the portable.



Richfield vapor-recovery plant at Watson, Calif.

Turning Waste Vapors into Money

Oil Industry Converts Vapors Formerly Wasted into Gasoline and Fuel Gas and Thus Saves Many Millions of Dollars Annually

By A. S. TAYLOR

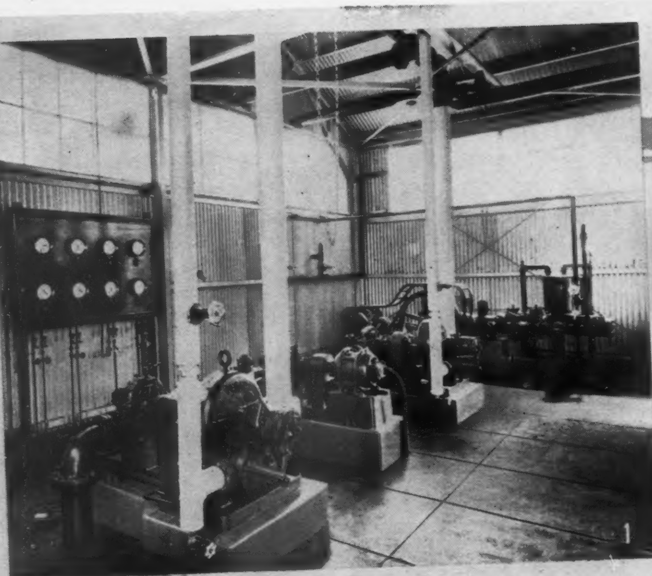
BACK in 1919, the United States was faced with a possible shortage of gasoline. Because of that situation the Federal Bureau of Mines made a detailed field investigation; and as a result of that work it was revealed that in one stage only of handling crude oil the volume of gasoline that evaporated equaled one-thirtieth of the country's yearly gasoline production. That loss occurred during the brief span of a few days in which the oil was stored on leases before being taken by the pipe lines. In the Mid-Continent field, alone, that particular loss amounted to 122,100,000 gallons annually. Imagine, then, what the total wastage must have been the country over at that time.

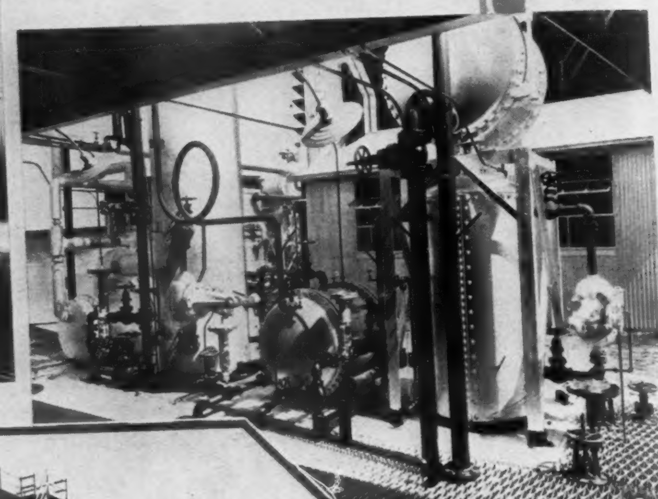
Further investigation brought to light that the gasoline in crude oil evaporates from one-half to six-tenths as rapidly as the same gasoline after being distilled and stored—all evaporative conditions being the same. The Bureau of Mines in elaborating on this subject some years ago made this statement: "Many wastes in oil fields are called 'necessary'. By this is meant that the cost of preventing the waste is greater than the gain through saving. Evaporation losses have fallen heretofore in this category, but now they must be considered unnecessary. In other words, it is no longer economical for any handler of crude oil to permit losses through evaporation".

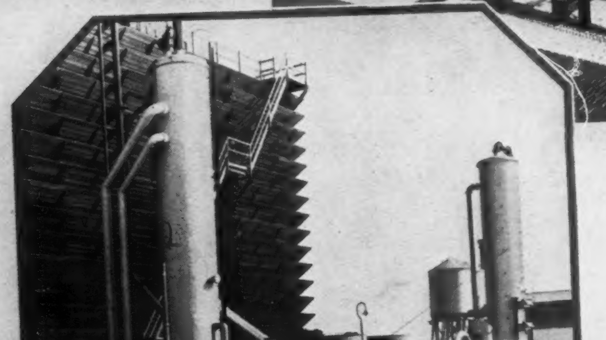
The purpose of the foregoing reference to the past state of the art is to emphasize improvements that have since been made by some of the outstanding companies in the industry. They have achieved these through effectual efforts to reduce evaporation losses in the handling of the crude oil prior to its delivery to the refineries and through means now employed by them in the treatment of still vapors in the refineries. Like every other development in engineering, more and more skill is being displayed as time goes on in checking and in preventing evaporation losses; and attention is now directed to what has lately been accomplished by the Richfield Oil Company of California. The details have been graciously furnished us by Mr. H. R. Linhoff, manager of the gas department of that concern.

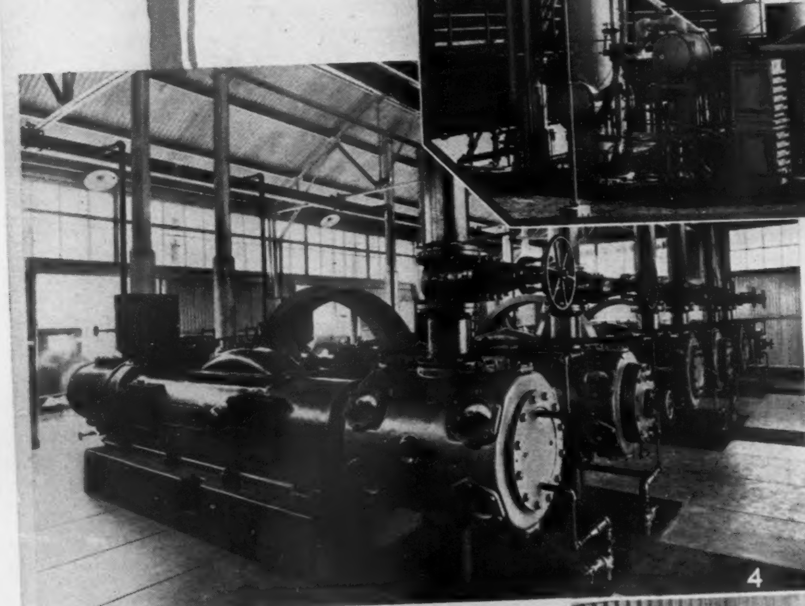
The stoppage of evaporation losses through vapor recovery pays for itself in two ways: First, it prevents the loss of a valuable commodity and turns it into a marketable product; and, second, by arresting the escape of inflammable gases it reduces the hazard of fire and its probable monetary sacrifices. The Richfield Oil Company has at its Watson refinery, in California, a typically up-to-date vapor-recovery and fire-prevention installation that is characterized by a number of exceptional features. The plant was designed to handle a maximum of 5,000,000 cubic feet of vapors daily at a gage pressure of 40 pounds per square inch. This arrangement provides considerable leeway for further expansion of the refinery.

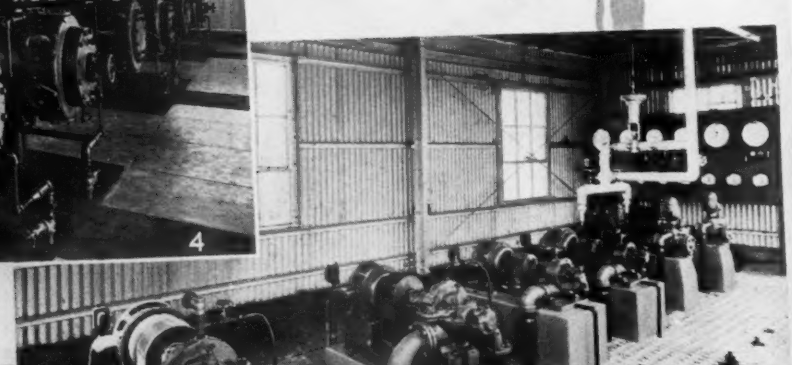
Vapor recovery and fire prevention at modern oil refineries have reached the stage that can be properly dignified as scientific; and this important work is bringing about commensurate returns in dollars and











1—Compressor room containing air starting unit and jacket and absorber water-circulating pumps. 2—Close-up of stabilizer showing arrangement of kettle, column, heat exchanger, reflux condenser, and reflux accumulator. 3—Distillation system with water separators and gasoline-line accumulator on the left. 4—Compressor plant made up of six units. 5—Water reflux and feed pumps for stabilizer.

cents. The Watson plant was reared and equipped at an outlay of about $200,000. It was possible after a 30-day period of practical operation to estimate that the plant would pay for itself in the course of only three months and that it would show a profit annually of substantially $750,000.

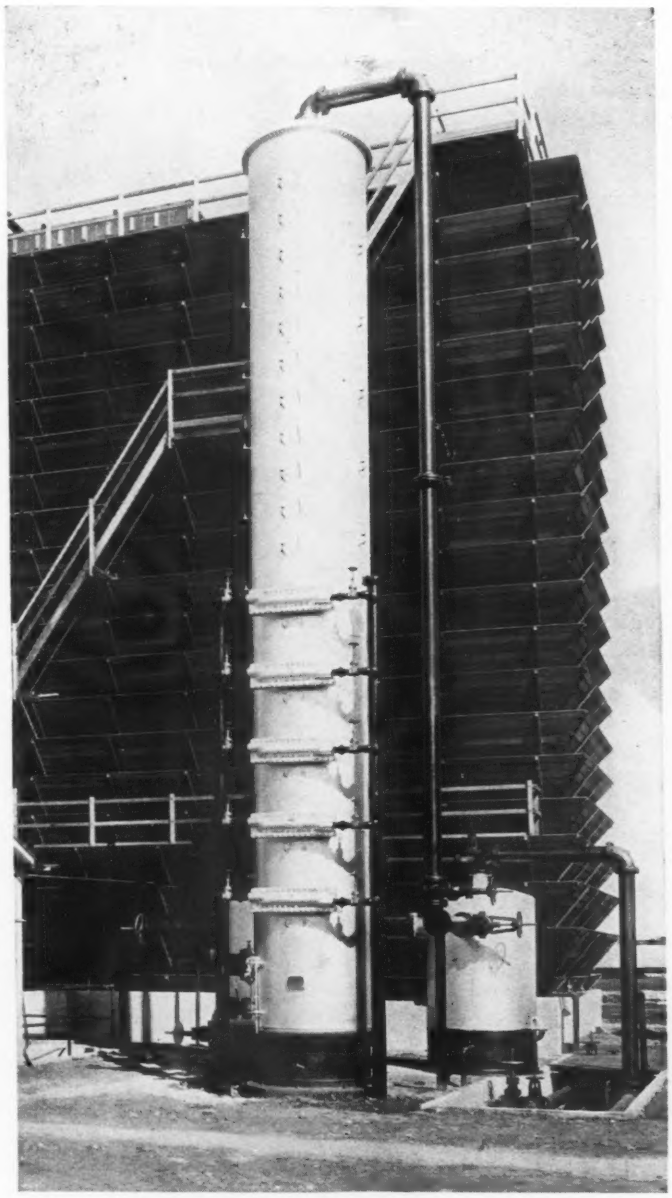
The term "vapor recovery" has now replaced the older expression of "evaporation loss"; and the new term is used in the petroleum industry to apply to the recovery and to the utilization of production, refinery, and tank-farm vapors. Producers and refiners give consideration to these vapors where once they were prone to neglect them; and in this changed attitude we have another example of the widespread tendency towards increased efficiency. Indeed. the very salvation of the industry depends largely upon this altered conception of the industry as a whole.

The pumping of oil and changes of temperature of oil in a tank farm induce the vaporizing of certain valuable fractions of the oil; and virtually all these fractions can be profitably recovered and the gas remaining thereafter can be used for fuel. Losses of this nature can be lessened by insulation, water seals, and floating roofs; but they cannot be done away with entirely without recourse to some system for collecting and recovering the vapors. A system of this sort serves a number of purposes: It utilizes receiving-house and tank-farm vapors by extracting therefrom a product similar in quality to natural gasoline; and it lessens or eliminates a serious fire hazard. A further important function is the reduction of air content of the vapors in the tanks.

In addition to the usual tank vent valves, such a system includes explosion relief valves, flame arresters, tank regulators, vapor-collection and repressuring pipeline systems, a compression plant, an absorption plant, and a stabilizer plant. The removal of part of the gasoline fractions from the so-called waste vapors is effected by compression and cooling, while the remainder of these fractions is recovered by absorption in oil, by redistillation, and by condensation.

By pumping air-free dry gas, as required, into tanks, the air content of the vapors emitted by the oil in storage is reduced proportionately. When a tank is being pumped out or the contents of a tank drop in temperature, and when the release of vapors from the oil is not sufficient to fill the space caused by the rate of pumping or the drop in temperature, then, instead of taking in air to fill the space, air-free gas is admitted to the tank. This neutralizes or greatly lessens the fire hazard. Incidentally, the reduction of air content of the vapors lessens by just so much the oxidation and the corrosion of tank structures. The principal objects of a complete vapor-recovery system are to garner gasoline and dry gas that would otherwise escape into the atmosphere, and to minimize as far as practicable the likelihood of fire in any part of a refinery.

The new vapor-recovery system installed at Watson is made up of tank regulators, a vapor-collecting and repressuring circuit, a 3-unit compression plant, an absorption tower, a distillation system, a high-pressure stabilizer, and a special cooling tower. The vapors utilized are drawn from the look boxes of five crude-oil distillation units and 75 active tanks containing high-gravity crudes, high-gravity refined oils, motor fuel, and natural gasoline. The vapors collected and passed through the recovery plant contain on an average of from 10 to 12 gallons of gasoline per 1,000 cubic feet. The application of vacuum through the medium of tank regulators automatically induces the collection of the gas. The regulators perform the double function of pressure and of vacuum regulators, and are controlled by a pilot valve that is operated by a single diaphragm. When the pressure in the tank reaches a predetermined point, vapors are allowed to pass outward into the collection line; and when the pressure drops so as to create a partial vacuum, that part of the regulator connected to an air-free dry-gas line opens and a given volume of the gas enters the tank. The regulators are sensitive to a variation of pressure or vacuum corresponding to one-tenth of an inch of water. A similar control system regulates the collecting of waste vapors from the distillation units.



Absorption tower that plays an important part in the vapor-recovery process.

After passing from the tanks, or on leaving the receiving houses, the vapors are led by suitably disposed lines to a central drainage point; and the removal of condensate is automatically accomplished. To guard the compression plant against failure of the foregoing system, a horizontal-line scrubber is interposed near the plant. This scrubber is also equipped with a vacuum unloader. The compression plant which collects vapors and delivers them to the absorption tower is equipped with three XG direct-connected, 180-b.hp. Ingersoll-Rand gas-engine compressors. These machines can handle gas ranging from a vacuum corresponding to 10 inches of mercury to a gage pressure of 40 pounds. Each unit has an adjustable clearance head to facilitate handling variable loads. This feature, together with the number of compressors, makes it possible to maintain a continual vacuum on the suction side of the compressors. Effective means have been provided to safeguard the machines against condensate, because slugs of gasoline or of water might seriously damage the compressors when starting them. Each compressor is provided with a separate lubricator to feed castor oil to the compressor cylinders so as to neutralize the condensation of gasoline in the cylinders. Castor oil will not mix with gasoline.

As has already been mentioned, the removal of some of the gasoline fractions from the vapors is effected by compression and condensation, and the remainder is recovered by absorption. The absorber is, therefore, the most important part of the recovery system. The company's engineer, accordingly, selected an absorber which would extract the greatest measure of gasoline fractions from the waste vapors. The absorption tower is of the bubble-cap type with 16 plates capable of handling in the course of 24 hours 5,000,000 cubic feet of gas; and it has an oil circulation of 500 gallons a minute at 40 pounds pressure.

Signal Hill with its bristling crown of derricks.

The Inman Company

In connection with this absorber there is an intercooler system made up of five cooling sections known as "U" type, "K-fin" sections. Each tube is wrapped with an aluminum rib-bon, at right angles to the tube, so as to form heat-collecting fins. The low velocity of the oil while moving past the tubes and the frothy condition of the oil make this provision necessary. Each section contains 406 square feet of effective cooling surface. Because the heat of absorption is removed as it is evolved, it is possible with these intercoolers to obtain a more highly saturated fat oil. The mean temperature of the oil has a definite effect on the extraction efficiency obtainable with a given oil-gas ratio.

Oil and water circulation for the absorption plant is provided by a General Electric-Cameron triple-pump unit. A duplicate set of pumps of the same type, connected to a Terry steam turbine, serves as a standby. Each unit has a capacity, per minute, of 1,600 gallons of water and 300 gallons of lean oil.

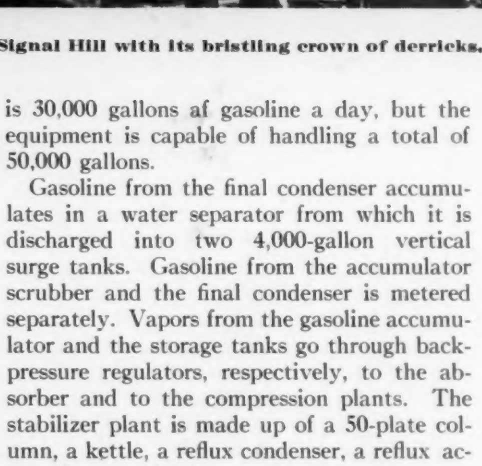
The vapors from the fractionator are taken to the top of the water-cooling tower where they pass through a primary box-type condenser. From that condenser the condensate and the uncondensed vapors go to a reflux accumulator. The uncondensed vapors and excess condensate are delivered to the final condenser; and the reflux is withdrawn from the accumulator and dehydrated by a water separator located at ground level. The reflux is discharged over the top of the accumulator by the difference in elevation between the reflux accumulator and the top of the fractionator. The normal load of the circuit is 30,000 gallons af gasoline a day, but the equipment is capable of handling a total of 50,000 gallons.

Gasoline from the final condenser accumulates in a water separator from which it is discharged into two 4,000-gallon vertical surge tanks. Gasoline from the accumulator scrubber and the final condenser is metered separately. Vapors from the gasoline accumulator and the storage tanks go through back-pressure regulators, respectively, to the absorber and to the compression plants. The stabilizer plant is made up of a 50-plate column, a kettle, a reflux condenser, a reflux accumulator, and a heat exchanger.

The stabilizer plant differs somewhat from other installations of the same nature in that no cooler is employed to handle the finished gasoline. The heat exchanger is designed to utilize the total heat available in the finished product for the purpose of heating the feed to the column. The gasoline leaves the heat exchanger at a temperature of 80° F. The functioning of the column is regulated by a differential feed controller, a differential reflux controller, and a recording top-temperature controller. The amount of steam admitted to the kettle regulates the top temperature; and this control is necessary because of variations during the day in the composition of the feed.

The cooling tower for the plant is of fourteen sections and of the atmospheric type surmounted by a primary box-type condenser. Without going into details, this tower, under normal conditions and with a 5-mile wind, is capable of cooling 1,600 gallons of water a minute from a temperature of 88° F. to an average temperature of 70°. Loss of water due to windage is reduced greatly by means of adjustable spray deflectors mounted on the lee side of the tower, between decks. The overall dimensions of this tower are 28 feet in width, 91 feet in length, and 55 feet in height. It is constructed of selected California redwood, held together with brass bolts and copper nails, and so designed that guy wires are unnecessary.

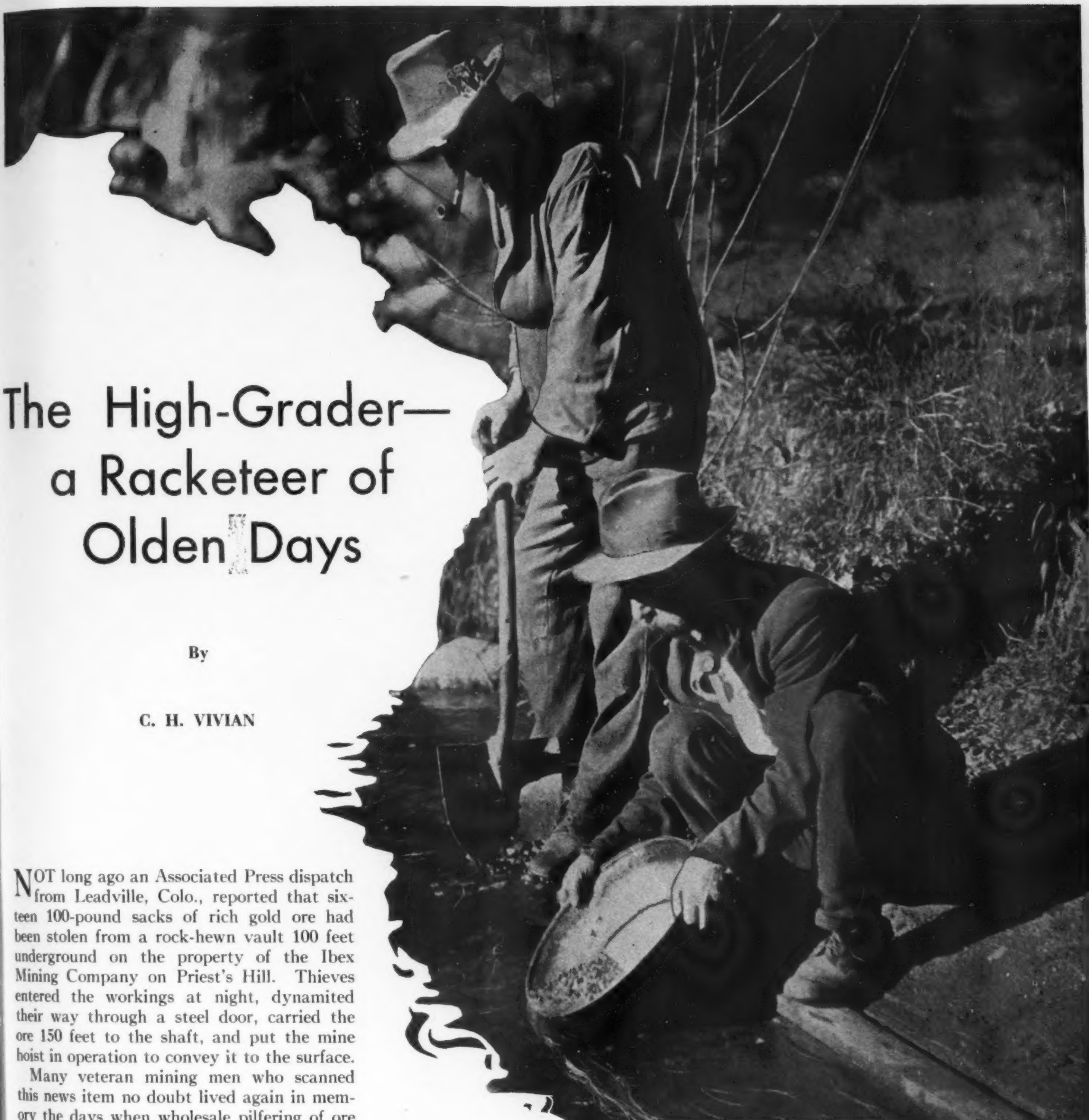
In the selection of materials and apparatus, and in their assembly and arrangement, Mr. Linhoff exercised supervisory control; and he was directly responsible for the design of certain important parts of the plant. The point that will interest persons not familiar with the technicalities of the subject is that this installation, besides adding measurably to the safety of the refinery and the security of the operatives, is the means of turning what has heretofore been a source of loss into a very handsome return annually—paying for itself several times every twelvemonth.



The High-Grader—a Racketeer of Olden Days

By

C. H. VIVIAN



Photos, Ewing Galloway, New York

Miners searching for "colors" with a gold pan.

NOT long ago an Associated Press dispatch from Leadville, Colo., reported that sixteen 100-pound sacks of rich gold ore had been stolen from a rock-hewn vault 100 feet underground on the property of the Ibex Mining Company on Priest's Hill. Thieves entered the workings at night, dynamited their way through a steel door, carried the ore 150 feet to the shaft, and put the mine hoist in operation to convey it to the surface.

Many veteran mining men who scanned this news item no doubt lived again in memory the days when wholesale pilfering of ore abounded, days when Cripple Creek, Goldfield, and other boom camps were infested with illicit gold refineries masquerading as legitimate assay offices. Up to 50 of these outlets for stolen ore sometimes flourished in a single district, and they persisted in spite of and in defiance of law. Even dynamite failed to drive them out of Cripple Creek. The word "racketeering" had not yet been coined; but all the pernicious elements that it connotes were present. Every mining company had its uninvited and unwelcome partners who declared themselves in on the profits by the simple and effective method of systematically carrying away small amounts of high-grade ore every time they went off shift. Meanwhile, as employees, they accepted pay from the mines they were robbing.

This practice, which developed into an art, went by the name of high-grading. Mine owners tried in vain to stop it. They could catch plenty of miners with their pockets full of "picture rock," but could seldom convict them. It was practically impossible to empanel a jury without getting two or three high-graders on it. Merchants and the general public condoned high-grading because those doing it were very often their relatives, close friends, or good customers. Anyhow, it was a trade tonic. It put more money in circulation and made for a liver camp.

The miners, themselves, calloused their consciences and convinced themselves that high-grading constituted no infringement upon the moral code. They were a bit socialistic about it all. They recognized the wrongfulness of stealing, but drew a fine line of distinction between stealing and high-grading. The ore they took home with them was looked upon as a sort of commission for services rendered the mine owners. Many miners held that a share of the mineral was theirs by right of discovery. The Lord had put it into the ground and it was meant for the one that actually dug it out.

There was also a feeling that it was no great crime to take something from those who had plenty. The large mine owners were looked upon as industrial tyrants, rolling in wealth and growing wealthier from the toil of the men who dug for them. One who wouldn't do a friend out of a cent thought it quite a smart accomplishment to transfer to his own pockets some of the profits that the soulless corporations were wrenching from the laboring classes. Something of this attitude is reflected in the following news correspondence from Goldfield in the *Engineering & Mining Journal* for June 4, 1910:

"The jury in the case of H. L. Dresser, charged with high-grading in the Consolidated mill, where he formerly worked on the concentrating tables, has been dismissed for failure to reach a verdict. The defendant was arrested as he was coming off night shift at the mill. It is alleged that in his pockets were found several pounds of concentrates valued at $200. A second trial will follow in a couple of months, although it is common talk in Goldfield that a jury cannot be secured that will convict a man of robbing the Consolidated".

Cripple Creek assayers waxed fat of pocketbook from the proceeds of stolen ore. Ordinarily they paid the high-grader 50 cents on the dollar for the value of the ore he brought to them for disposal. This left them 50 cents profit on every dollar's worth of ore handled, minus their operating expenses. Some assayers furnished the miners with canvas belts lined with flannel and containing pockets between the two layers of cloth. Small sacks to fit under the armpits or to hang in the boot tops were also devised. Assayers maintained regular collection routes to gather up the stolen ore from the miners after they had come off shift. Sometimes they went to a man's room, or perhaps the miner left his day's gleanings in one of the numerous saloons or cigar stores to be picked up by the assayer or his trusted agent.

Once a Cripple Creek assayer arbitrarily reduced the payment to the miners to 25 per cent of the ore's value. He had a good location near one of the large mines. It was handy for the men to stop in on their way home from work. In view of this he thought he could dictate his own terms. One night, soon after he had cut the rate of payment, he was set upon and beaten and given a certain number of hours to leave town. He left.

When Cripple Creek was in its heyday, one of the mining papers commented editorially: "The stealing of rich ore appears to be one of the penalties that the rich mine owner must suffer for having rich ore in his vein. Until recently it has been impossible to secure convictions for such thefts at Cripple Creek, even when the evidence has been strong."

The mine owners made many efforts to stop high-grading, but with little success. The ore was so rich in certain spots that a pound or two of it was worth many dollars. This amount could be secreted in a lunch pail, cap, or elsewhere about the person without great difficulty. Finally, the change system was devised in an attempt to curb the practice. Orders were issued that miners coming off shift should change all their clothing before going home. Change rooms were established with company representatives present to see that no ore was transferred from working clothes to street clothes. This was viewed as a radical step by the miners' union, which fought it bitterly. It was one of the chief underlying causes of the strike of 1903-4 which precipitated wholesale murder and property destruction and placed the entire district under martial law for many months.

Pack-mule train moving silver ore concentrates from

Eventually high-grading was brought under partial control at Cripple Creek through the inauguration of the card system. The mine owners formed an association which established offices with a secretary in charge of each. Before a miner could seek work at any of the larger properties he had to secure a card from one of the secretaries. No card was issued unless the secretary who interviewed the man was satisfied as to his character. This system was started in June, 1904, and is still in use. It had the effect of preventing radicals and agitators from obtaining employment; and some of them were forcibly ejected from the camp. A complete record was kept on file of every man employed in the mines.

In spite of all these measures a certain amount of ore stealing persisted. Miners resorted to strategy and artifice to frustrate the restrictions and watchfulness imposed by the owners. Rich ore was loaded out as muck, to be later recovered from the dump or to be taken off the cars and secreted by a confederate on the surface. Timbermen coming up for supplies carried with them a few pounds of ore and cached it where it might be retrieved under cover of darkness. Foremen in league with the miners were bound and gagged in fake holdups. Ore

s from out-of-the-way mining district in the Colorado Rockies.

sorters became so expert that they could conceal a piece of high-grade about their clothing even while under the eyes of a guard.

Failing to curb the practice by measures taken at the mines, the mine owners set out to stop the illicit trade of the assayers. They checked the ore shipments of various suspected assayers to smelting plants in Colorado. Learning that this was being done, the assayers began shipping their ores to San Francisco, Salt Lake City, and El Paso smelters. Some of them sent their gold ores to friendly assayers in Aspen, Colo., a silver camp. There they were mixed with silver ores before being forwarded to a smelter. A reduction plant for the making of bullion sprang up in the camp, making it possible to extract the gold from small lots of ore and ship it direct to the mint. This plant could put through a ton of ore in a night, and in the morning there would be no evidence of its work.

On the night of February 23, 1902, eight assay offices in various parts of the Cripple Creek District were wrecked with dynamite. Buildings that housed them were badly damaged, and delicate instruments and balances were destroyed. It was generally accepted that these acts of violence were intended to rid the camp of buyers of stolen ore. No one was ever brought to trial for the crimes. The camp had passed its production peak at this time. The richest pickings were gone, but high-grading continued. In 1911 the Portland, Golden Cycle, and Stratton's Independence mines applied to the Federal court for an injunction to restrain 48 assayers from buying ore from the miners. The injunction was refused then, and again in 1914, at which time the applicants estimated that $500,000 worth of ore was being stolen each year. In 1915 the crusade to wipe out high-grading started anew. Mine operators declared that it was increasing. Five miners were arrested and made confessions implicating twelve others. In April, 1915, an injunction was obtained in the district court enjoining the 27 assayers then in the camp from purchasing ore from miners. In the same year the Colorado Legislature passed a law placing assayers under bond and requiring them to keep a record of all transactions. Provisions of the law were made more stringent in 1917.

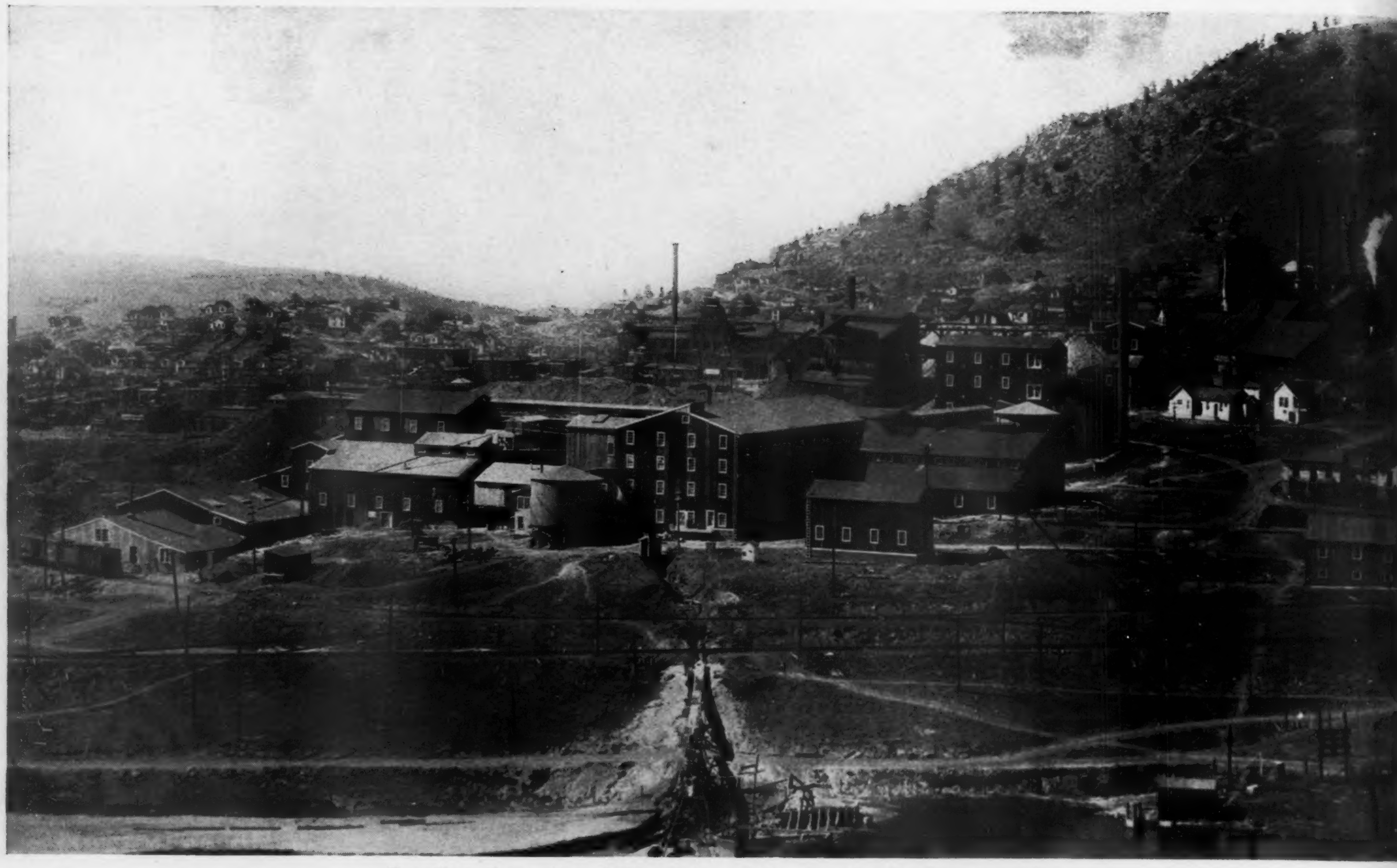
While Cripple Creek probably led all the gold camps in the total value of ore stolen, Goldfield undoubtedly was the scene of the most intensive campaign of high-grading over a brief period of time. Around 1906, when the richest ore was coming from the ground, mine owners without a streak of valuable ore had great difficulty in keeping a working force. The miners shopped around until they found a job that would permit them access to high-grade ore. Any miner working on the Hayes-Monnette lease in the Mohawk Mine could sell his job for a fancy price any time he chose. The ore was so rich that a man could easily carry away $1,000 worth in his pockets.

All sorts of special equipment was devised to secrete ore about the person. Leg pockets—long, narrow canvas bags—were hung down the trouser legs. What was known as an ore harness consisted of a double canvas shirt with stitched pockets between the two thicknesses of cloth. Double-crowned hats had a compartment large enough to contain five pounds of ore. Cases are on record of men coming up the shafts so heavily laden down that they could not get out of the buckets. Work on leases was much sought after. The lessees had only a limited time to get out as much ore as possible. They countenanced almost anything to keep miners. They could not afford to be too squeamish.

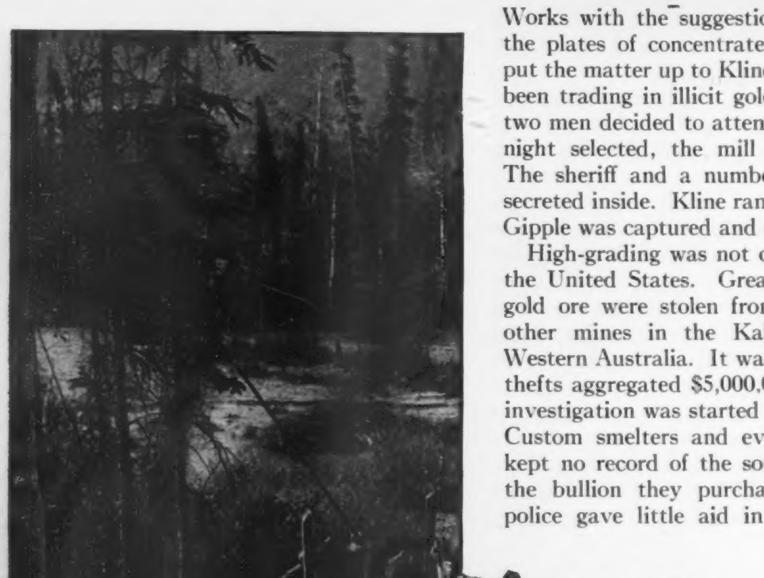
In 1906 there were 37 assay offices in Goldfield. A fifth that number would have sufficed for legitimate needs. Production of the mines for the year was $7,026,154; and it was conservatively estimated that 18 per cent more was stolen.

In reporting on the output of the camp for 1906, Waldemar Lindgren, of the United States Geological Survey, wrote: "The practice of stealing ore was carried on to a disgraceful extent during the year in the rich mines of Goldfield. The principal mine officers estimate that ore to the value of $1,250,000 was appropriated and that ore worth $250,000 was recovered from the thieves. Much rich ore is probably secreted, and will gradually reach the mints during 1907."

Not until June, 1908, was a high-grader convicted. Two miners working on a lease were caught with ore worth from $2 to $20 a pound and were found guilty of theft. There had been many arrests previously, but none of them led to a conviction. About the only way mine owners could obtain evidence that would convince a jury was through setting traps to catch the thieves red-handed. In one such case a man named Gipple, who had long been suspected of crooked dealings in ore, was approached by the night watchman for the Nevada Goldfield Reduction



Small section of Leadville, Colo., with mines in the foreground.



Stakes planted by as many different claimants to land during gold-rush days.

Works with the suggestion that they scrape the plates of concentrates. Gipple, in turn, put the matter up to Kline, a jeweler who had been trading in illicit gold on the side. The two men decided to attempt the job. On the night selected, the mill was left unlocked. The sheriff and a number of deputies were secreted inside. Kline ran and was shot dead: Gipple was captured and convicted.

High-grading was not confined to mines in the United States. Great quantities of rich gold ore were stolen from the Kalgurli and other mines in the Kalgoorlie District of Western Australia. It was estimated that the thefts aggregated $5,000,000 in 1906; and an investigation was started by the government. Custom smelters and even the Perth Mint kept no record of the source of the ore and the bullion they purchased, and the local police gave little aid in tracing fraudulent dealings. Many mine and mill superintendents and foremen were in league with the criminals and sold them ore, bullion, and amalgam. Investigation showed that during one year approximately $2,200,000 worth of gold, not reported as production by the mines, was entered for export or lodged in the Perth Mint. In many cases the thieves held and pretended to work worthless mines as a cloak for their illicit sales.

Australian high-graders proved just as adept as those in America at inventing ingenious means for carrying away gold. Candles used underground were hollowed out to secrete ore in small amounts. Mine blacksmiths drilled holes in the heads of picks for certain favored friends who would throw some of the ore proceeds their way. Hollow boot heels were very popular with the miners. Mill hands often rode bicycles and carried hand air pumps into which they could draw some of the rich gold-cyanide solution by a single movement of the plunger.

When Cobalt, Ont., was opened up in 1907, silver ore worth as much as $1 a pound was found practically at the surface, and much of it was carried off by miners and visitors. Miners were not searched, and few restrictions were placed on them. Later on, when open-cut work had given way to underground mining, high-grading became systematized. The thieves operated a small smelting plant at Chippewa and had confederates at Cobalt and Ontario to help market the metal obtained. Canadian laws, though stricter than those of the United States, failed to stop the practice. Up to 1910 only eleven arrests had been made at Cobalt. In April of that year

Valley in the San Juan Mountains of Colorado with the mining camp of Silverton in the distance.

the Lucky Godfrey Mine, at Elk Lake, Ont., shipped a carload of ore valued at $40,000. When it reached the smelter the sacks were found to contain only low-grade ore. The sacks were the same ones that had left the mine, but their contents had been removed and the substitution made.

During the World War the price of tungsten rose to levels that made high-grading profitable, and it was freely practiced at various points in the western United States. A peace officer, searching Mexican huts in the Las Guijas District in Arizona for firearms, found a number of sacks of wolframite. The occupants of the huts were employed by the International Tungsten Company. The mine manager was notified of the find and started an investigation. The trail led him to Tucson, where a 5-ton lot of ore, worth $5,000, was discovered in a testing plant. The miners had been carrying off the ore in small bits in their pockets and lunch pails. Mexican high-graders always proved troublesome. They didn't mind jail terms as long as they eventually got out and could renew their thievery. The only effective means of dealing with them proved to be blacklisting them for work in the mines.

Tungsten high-grading was also carried on at Randsburg and Atolia, Calif., where the ore produced was scheelite. Forty purchasers of ore were active, some of them women. They paid $1 a pound for high-grade ore and got $2 to $3 a pound for it from eastern buyers. "Stolenite" was the local name applied to the ore; and it was in such general circulation that it passed for legal tender at the poker tables that abounded in the camps.

Sometimes the painstaking efforts of the high-grader went awry. One miner in a Nevada camp husbanded stolen ore until he had accumulated $50,000 worth. Then he quit his job and prepared to go away. He was arrested and his fortune confiscated when he attempted to sell the ore. The elements of a detective story are present in one case where the law reached out 2,000 miles to bring high-graders to justice. On January 21, 1913, four men were arrested at the Grand Central Station, New York City, as they stepped from a train from the West. Upon being searched, each was found to be wearing a close-fitting money bag under his shirt. The bags contained coin, bills, gold dust, and high-grade gold ore. When detectives presented the baggage checks taken from the men, they received four small iron-bound chests. Each was heavily laden with gold ore.

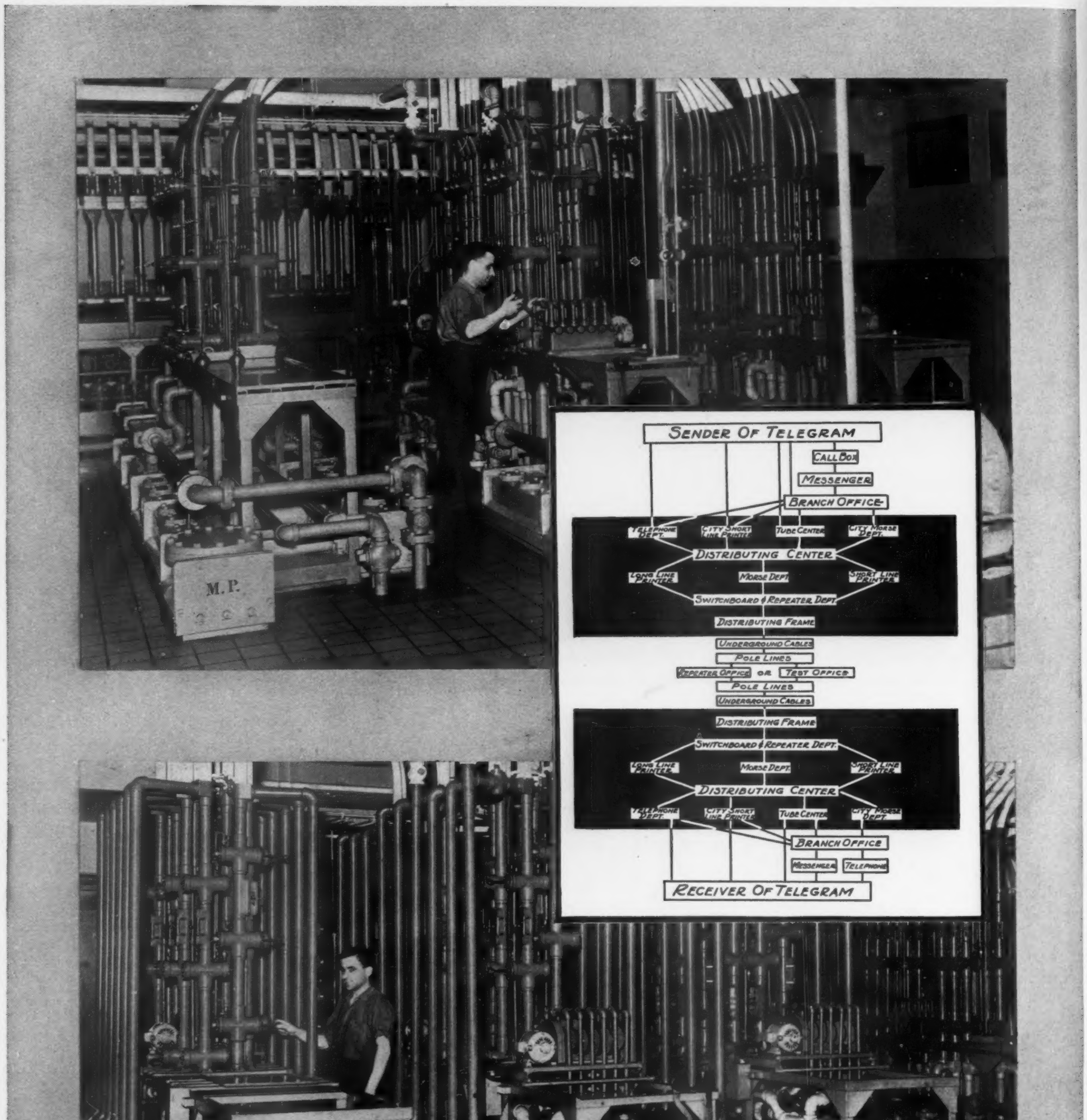
The ore was from the Little Jonny Mine at Leadville, Colo., where the four men had been employed. One day a saloon keeper in Leadville exhibited a 24-pound specimen of high-grade. Sheriff Harry Schraeder happened to hear of the chunk of "picture rock" and called around to look at it. He inquired as to its source. The saloon keeper said he had bought it from a miner. This started an investigation, which eventually led to a cabin occupied by two men. A quantity of ore was found in the cabin, and it was learned that four other recent occupants had left for New York two days before. A telegram to the New York police led to their interception as they were leaving the train to buy steamship tickets for Europe. Their dreams of a life of ease were abruptly ended.

POROUS HARD RUBBER SUITABLE FILTERING MATERIAL

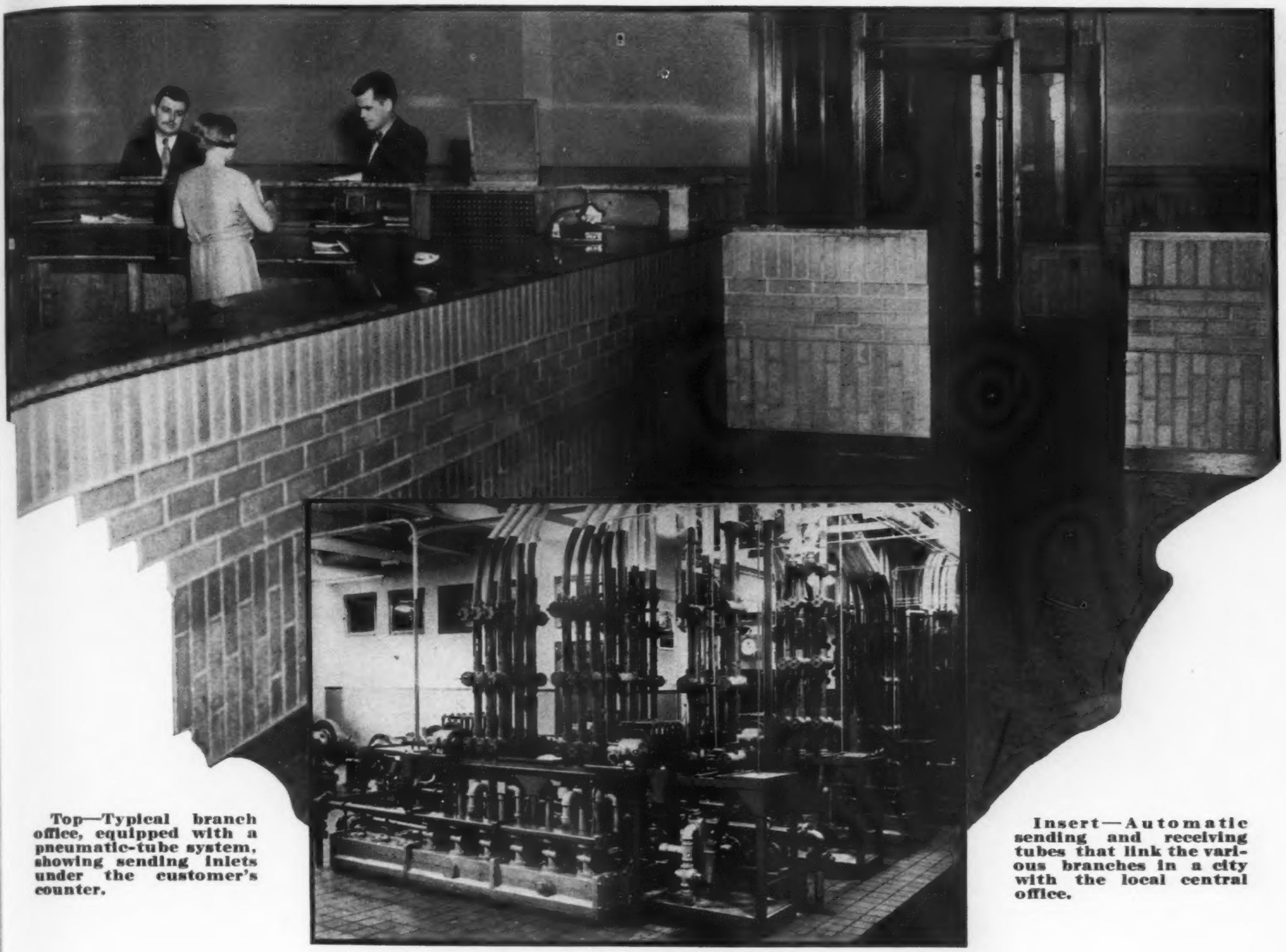
POROUS hard rubber for filters, filter-pipe rings, and for plate diaphragms for electrolytic cells are said to be highly suitable for all kinds of filtration, clarification, and purification work. They are being manufactured in Germany, where they are in practical use in chemical plants, for filtering river water, for cleaning compressed air, and for other allied purposes.

Owing to the nature of rubber, the strength and the porosity of the ultimate product can be varied to meet a wide range of requirements. Filters are being produced that are from 25 to 60 per cent porous or, put the other way round, from 40 to 75 per cent solid. Of course, the greater the porosity of the plates the lower their mechanical resistance. This is offset by placing plates of this description, when they are to be subjected to high pressure, on 1-inch mesh screens for support.

Porous, hard-rubber plate diaphragms for electrolytic cells offer, so it is claimed, much less resistance to electric current than is ordinarily the case because of their comparative thinness and their variable permeability. The choice of plate depends on the conditions under which the filter is to work—on temperature, the substance to be filtered, and whether or not vacuum or pressure is to be applied. Beyond a temperature of 158° F., the filters cannot be used under pressure because the rubber will soften and bend. Neither will they do for filtering any material that will dissolve the rubber or make it swell.



In a central office of the Western Union:
Top—Branch-office automatic sending-tube inlets. Center—Flow sheet of various routes that a telegram may follow between sender and receiver. Bottom—Branch-office automatic receiving-tube terminals.



Top—Typical branch office, equipped with a pneumatic-tube system, showing sending inlets under the customer's counter.

Insert—Automatic sending and receiving tubes that link the various branches in a city with the local central office.

Pneumatic Tubes Speed Telegraph Service

Something About the Ways in Which the Western Union Telegraph Company Utilizes Pneumatic Tubes in Hastening the Dispatch and the Reception of Messages.

By **A. DRENKARD**

WHEN a customer steps to the counter of a Western Union commercial office to send a telegram he takes it for granted that his message will be delivered with the utmost dispatch, but he probably little realizes the modern means by which the telegram is handled.

For a great number of years telegrams were sent almost exclusively by the Morse system with the well-known telegraph key and sounder, and this equipment is still visualized by most people when they see the familiar slogan, "Don't Write—Telegraph". However, modern engineering and business methods have so changed the telegraph industry that, at the present time, a very small percentage of telegrams is handled by the Morse system. Automatic sending and receiving apparatus have been developed that now make it possible to transmit as many as eight messages over one wire at a time. Methods of collecting and delivering messages have also been greatly improved.

Central offices are necessary to efficiently and economically receive and distribute telegrams which are filed at various points and handled by different methods. Most of the telegraph traffic is between towns and cities and is brought to a central office in each. In the larger cities a number of branch offices are established, and all these are connected to the central office by some efficient means of communication.

Telegrams may reach the central office by one of several methods. The customer may file his message at a Western Union branch office, or he may turn the knob of a call box installed in his office. This will bring a messenger to collect the telegram. Or by using any telephone the customer may be connected to an operator in the Western Union central office by merely saying "Western Union". In many cases a short-line printing telegraph circuit, a pneumatic tube, or a private telephone circuit is carried directly from the central office to the customer's office. Various facilities are provided for conveying telegrams from the branch office to the central office, depending upon the volume of business and the distance between the two. If the branch office is some distance away and handles a large volume of business, a short-line printing telegraph circuit is installed. Where the telegraph file is light, a private telephone wire or a Morse wire may be used. When the volume of business is large and the distance not too great, a pneumatic tube is installed.

At the central offices there are facilities for receiving telegrams coming by the various routes and means just mentioned and for delivering them to their destinations as expeditiously as possible. Messages by tele-

Left—Main receiving-tube station in central office showing concentrator-tube terminals with openwork wire bends and, at the left, top of the bank of empty carrier tubes. Right—Concentrator hopper by which six tubes are made to feed into one tube.

phone, short-line printer, pneumatic tube, or Morse wire are placed on belt conveyors. The belts carry them to a distributing center, where clerks collect them and put them on other belts which, in turn, convey them to the long-line-printer, short-line-printer, or Morse departments. There the telegrams are sent out on the lines through underground cable conductors to the city limits, where the wires are transferred to pole lines. If the message is destined to a point less than about 200 miles away, the circuit passes through one or more test offices and enters the receiving central office in the same manner as it left the originating central office. When the stretch involved is longer, the circuit will pass through one or more repeater stations to keep the message impulses up to full strength until the telegram reaches the distant office. In the case of a cable, it is sent to one of the stations on the coast, where it is transferred to the cables. At the receiving central office the course of the message is just the reverse of that followed by it in the sending office, and it is delivered to the recipient by telephone, short-line printer, messenger, or pneumatic tube.

The Western Union Telegraph Company has approximately 500 branch-office pneumatic tubes in use throughout the United States, and also has several installations in foreign countries. The total length of these tubes is about 2,000,000 feet; and the entire plant represents an investment of more than $10,000,000. In addition to the branch-office tubes, about 600,000 feet of pneumatic tubes are used for interdepartment communication within central offices. All the equipment is specially designed; and all layouts are made by Western Union engineers to meet the company's requirements for safe and speedy handling of all business.

The simplest type of pneumatic-tube system consists of a tube between two points, an air pump for creating pressure or vacuum, a carrier for conveying the material being handled, a sending inlet into which the carrier is placed for dispatch, and a receiving terminal for discharging the carrier from the tube. The carrier is placed in the tube and blown or sucked to the receiving terminal, from which it is removed. By reversing the direction of the air flow in the tube it is possible to use a single tube for 2-way communication. In most instances, however, the Western Union tube systems consist of a pair of tubes—one for sending and the other for receiving, as the business is usually too heavy to be handled expeditiously in a single tube. The air is by-passed from one tube to the other at the distant end, and pressure from one side of the blower is applied to the outgoing tube and vacuum from the other side of the blower is applied to the incoming tube, making a closed loop in which the same air is circulated repeatedly. The closed loop assists materially in minimizing moisture condensation in the tubes.

Tubing of 16-gage steel and 2¼ inches inside diameter is used for all inside systems, while 14-gage copper tubing of the same diameter and laid in creosoted-wood ducts is employed for underground runs. Steel tubing within buildings wears indefinitely: the life of copper underground tubing is approximately 30 years. A section of tubing laid in Maiden Lane in New York City in 1885 was removed from beneath the street in 1923 after 38 years of service. That tubing, however, was No. 12 gage brass.

The standard Western Union pneumatic-tube carrier is 8 inches long so as to permit the insertion of telegrams without folding. The body is made of No. 16 gage fiber tubing 1⅝ inches outside diameter. The open end is reinforced by a collar of the same material and holds a message-retaining spring. At the other end a steel cap is riveted to the body, and a felt head, ½-inch thick and 2¹³⁄₆₄ inches in diameter, is riveted to the cap. A carrier with a body of transparent material has been developed recently. This is of value where it is necessary to relay carriers from

Left—Main office in New York City of the Western Union Telegraph Company. Right—Section of one of the main operating rooms in the New York central office with close-up of multiplex operating table equipped for sending and receiving messages.

one tube to any one of a number of others, because it enables reading the address on the telegram without removing the message from the carrier.

Most of the Western Union tubes have been operated for years at a carrier speed of approximately 1,200 feet a minute. Lately there has been a tendency to increase this considerably. Practically all the branch-office tubes in New York City are designed for a speed in excess of 1,800 feet per minute. Tubes up to 4,500 feet in length are operated by applying pressure and vacuum at one end only. Longer lines usually require power plants at each end. To attain speeds as high as 3,500 feet per minute in tubes more than a mile in length it has been found advisable to locate a booster or relay plant near the middle of the line. In this way it is possible to obtain high speeds more economically and without employing unusually high pressure or vacuum. The fastest tube in the Western Union system is in New York City. It operates at more than 3,500 feet per minute over a distance of 6,300 feet. The longest tube in the Western Union system, also in New York, is 12,500 feet between terminals, and it runs from the new Western Union Building at 60 Hudson Street to the Flatiron Building at 23rd Street. Because of its unusual length, however, it handles night messages only. The average branch-office tube line is about 2,500 feet from end to end.

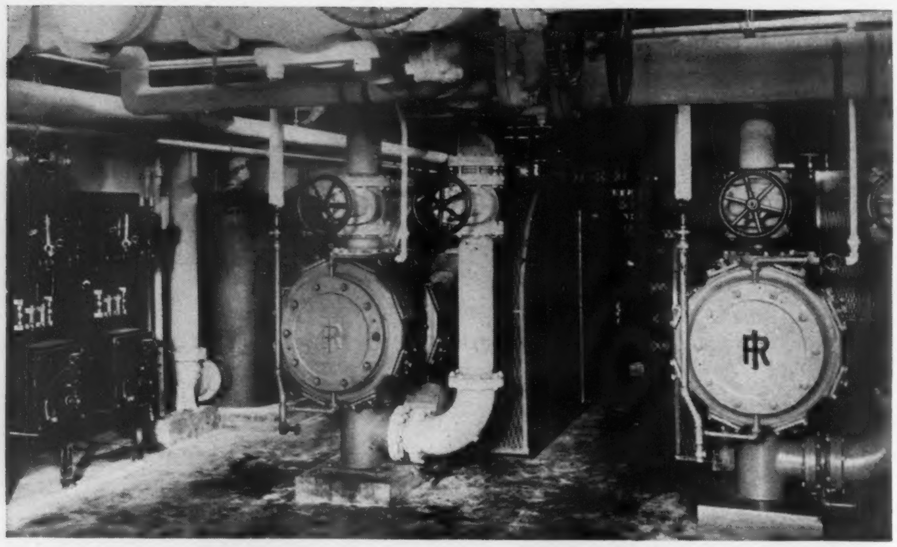
A pneumatic tube has a tremendous ultimate capacity. Test has proved it to be possible to dispatch carriers in a tube every two seconds and to transport them to the distant terminal at the rate of 3,500 feet per minute without any appreciable difference in transit time when the tube is either lightly or heavily laden with carriers. This means that with a load of eight telegrams per carrier the theoretical maximum capacity would be 14,400 messages per hour each way. At present, however, no tubes are loaded to any such capacity.

For the operation of an individual pair of tubes it is customary to utilize a separate, small blower. With a blower of this description, driven at a constant speed, it is possible to supply the tube with a constant volume of air so that a carrier, should it by any chance become blocked in the tube, can as a rule be released by the pressure that is built up behind it.

But where a large number of tubes enter a central office it has been found preferable to use large reciprocating compressors for their operation. In determining the size of machines to be provided for the purpose, it is estimated that there must be available for each of the tubes a matter of 80 cubic feet of air per minute, piston displacement, at the top speed of the compressor. It is usually the practice to install a sufficient number of machines so that any one of them may be shut down at any time; a spare compressor started; and the system still be run at normal speeds. However, the necessity of taking a unit out of service for any length of time has been very rare. Comparatively no trouble is experienced with any of the Western Union's compressor installations.

The compressors are seldom run at more than 5 pounds pressure and 10 inches of mercury vacuum. They are placed in the basement of the building, and a pair of 8- or 10-inch air pipes is run therefrom to the manifolds at the tube centers on the upper floors. The manifolds are of cast iron with 2-inch diameter holes on 9-inch centers. At each hole is a cock connecting with a tube. The pressure and vacuum on each line are regulated by the size of the cock opening. Auxiliary manifolds are attached to the tubes by means of 3-way or angle cocks so that the direction of air flow in any tube may be reversed in the event of a block.

The tube system installed in the new Western Union Building previously mentioned is the largest of all telegraph pneumatic-tube systems. It is made up of more than 50,000 feet of tubing; 24 branch-office tubes now



A typical up-to-date compressor installation serving a pneumatic-tube system.

terminate in the structure; and facilities have been provided for 36 additional branch-office tubes that will eventually bring the number up to 60. There is also a complete house-tube system that links up the various operating departments and executive offices. Sixty-five house tubes are now in service with provisions for an ultimate total of 90.

Each branch-office tube installation is divided into three separate systems—that is, high pressure-vacuum, medium pressure-vacuum, and low pressure-vacuum. The high pressure-vacuum system operates under 8 pounds pressure per square inch and 16 inches of mercury vacuum, and includes tube lines upwards of 5,000 feet in length. The medium pressure-vacuum system operates at 6 pounds pressure and 12 inches of mercury vacuum, and embraces tube lines between 2,500 and 5,000 feet. The low pressure-vacuum system operates at 2½ pounds pressure and 5 inches of mercury vacuum, and includes tubes less than 2,500 feet between terminals.

The entire house-tube system is run as a straight vacuum system. The carriers are sucked from an open-end bellmouth inlet at the central station to an outer station. There the air is by-passed around a combination sending-and-receiving terminal, and carriers are sucked back in another tube to the central station where the tube is connected to a low-vacuum manifold via a shut-off and regulating cock. The house-tube system operates at a vacuum of 2 inches of mercury.

The high and the medium pressure-vacuum tube systems are operated by a battery of four reciprocating compressors each of which is driven by a 60-hp. electric motor. Two are alternating-current and two direct-current machines, and they are so interconnected that one or more of the four units may be used for either system. Two high-speed, centrifugal compressors serve to operate the low pressure-vacuum system. These machines are geared up from a motor speed of 3,600 revolutions per minute to an impeller speed of 20,900 revolutions. Each of these machines has a capacity of 1,200 cubic feet per minute at 2½ pounds pressure and 5 inches of mercury vacuum. Three centrifugal compressors, running at 3,600 revolutions per minute and direct connected to the motors, are used to operate the house-tube system. Two of these units have a capacity of 1,600 cubic feet at 3 inches of mercury vacuum while the third has a capacity of 900 cubic feet at 3 inches of mercury vacuum. Two direct-connected centrifugal compressors, running at 3,600 revolutions per minute and delivering 1½ pounds pressure at 1,200 cubic feet per minute, operate the concentrator tubes, to be described later.

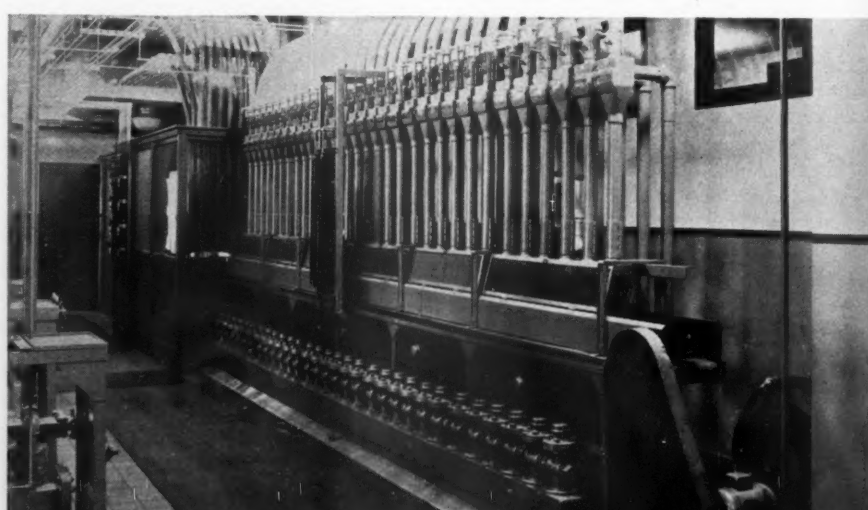
All pressure and vacuum manifolds, automatic sending inlets, automatic receiving terminals, and associate equipment are located in the pneumatic-tube control room on the eleventh floor of the building. A silica-gel dehydrating machine, which prevents condensation of moisture in underground tubes on humid days, is also in the tube-control room.

Incoming branch-office tubes terminate in groups of six automatic receiving terminals, and each group automatically feeds the carriers from its six tubes into one concentrator tube. These concentrator tubes run from the terminals on the eleventh floor to the main receiving-tube center in the main operating room on the fourteenth floor.

An automatic receiving terminal is composed of a length of tubing with three piston-type valves spaced vertically on 20-inch centers. Each valve consists of a piston, 3 inches in diameter and 6½ inches long, reciprocating in a cylinder 9 inches long. Each piston has a 2¼-inch hole bored through it near one end. The cylinders are connected to a pressure-vacuum timing system in such a way that the upper and lower pistons move together and the center piston moves in opposition to the other two. Thus, when the holes in the upper and the lower pistons are in line with the tube the solid portion of the center piston closes the tube, and when the hole in the center piston is in line with the tube the solid portions of the upper and the lower pistons close the tube. At no time is there a through path of air through all three pistons.

Each terminal can handle two carriers at a time between pistons. The pneumatic timing system which operates the pistons is so arranged that carriers drop from the six receiving terminals into the hopper in consecutive order so that carriers do not jam in the hopper. A group of automatic receiving terminals will feed carriers into a concentrator tube at the rate of 120 per minute without jamming. One of our photographs shows a group of six receiving terminals and a concentrator hopper.

The concentrator tubes, which are operated under pressure, discharge carriers in the operating room through openwork wire bends which dissipate the air. By using concentrator tubes it is possible to consolidate all branch-office receiving equipment on one table in the operating room, thereby gaining much needed space. This arrangement also improves the appearance of the operating room and provides flexibility in the locating of the



Receiving terminals of a house-tube system showing central station in the background.

tube center. In addition, the concentration of all automatic sending and receiving equipment in one room permits better maintenance.

When carriers arrive at the main receiving-tube center on the fourteenth floor, via the concentrator tubes, the messages are removed and placed on a belt which takes them to the main distributing center. There they are sorted and delivered by other belts to operators at the wires on which they are to be dispatched. The empty carriers are also conveyed by belt to a bank of 90 empty carrier tubes which runs vertically from the fourteenth floor to the main sending-tube center on the thirteenth floor. Empty carriers are sorted in these tubes, each of which has a carrier-retaining catch at the bottom. When a sending clerk wants an empty carrier he has only to press the catch.

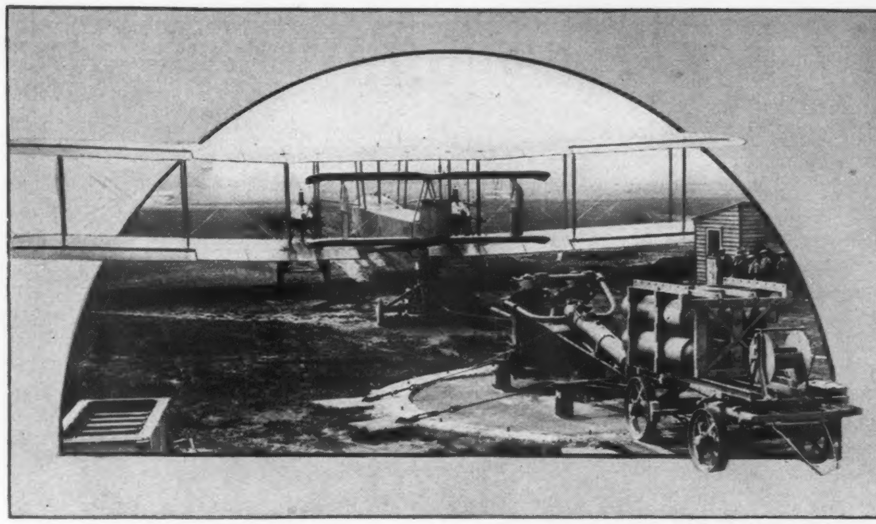
Messages coming from the wires and destined to be sent by tube are collected by belts and brought to the main distributing center, at which point they are placed on another belt which delivers them to the main sending-tube center directly under the bank of empty carrier tubes. There the messages are sorted; loaded into carriers; and, by way of gravity sending tubes, fed into the automatic sending inlets in the tube-control room on the eleventh floor where the branch-office tube, itself, begins.

The main house-tube central station is also located in the tube-control room. Messages originating in any office in the building and destined for any other office in the building must first be sent there. The clerk in attendance reads the destination of the message through the transparent carrier and dispatches it through the proper tube. Connections have also been provided between the house-tube center and the main receiving- and sending-tube centers.

The foregoing is a brief description of the pneumatic-tube system in the New York office only. A very large installation is also in service in the Western Union central office at Chicago, Ill. Large compressor-operated systems may be found in almost every big city in the United States, while new systems are now being installed in the new Western Union buildings at Jacksonville, Fla., and Boston, Mass.

SELF-TEMPERING CHISEL STEEL

FROM the Sheffield district of England comes the announcement of the development there of a new chisel steel which, so information has it, has already been put to many practical uses. The steel does not need to be quenched and tempered, as do ordinary chisel steels; it is only necessary, after the chisel nose is forged in the accustomed way, to heat the cutting edge to a temperature of 1,652° F. and to throw the work aside to cool. When the edge is ground to shape the tool is ready for service. In its hardened state, so the manufacturer says, the chisel edge will stand repeated blows from a sledge hammer without losing its edge when cutting 0.6 carbon-steel rails. It can, however, be sharpened with a file.



Photo, Keystone View Company, Inc.

Mobile pneumatic catapult capable of launching a heavy plane from the ground.

Airplane Catapult for Use on Land

A HUGE airplane, weighing 9 tons, was shot into the air at the Royal Aircraft Establishment, Farnborough, England, in the course of a recent demonstration of the first land-type catapult for launching big planes in small spaces. This catapult put a Virginia twin-engined bomber into the air in three seconds after a run of 100 feet, as compared with a usual take-off of nine times that distance.

Unlike the marine catapult, the new type launches its plane by traction instead of propulsion. The motive power is a compressed-air engine, which is geared to a drum. On the drum is wound a steel cable which is carried forward over the airport, connected by quick-release hooks to the underpart of the airplane fuselage, and passed over a pulley anchored to the ground at the end of the travel, whence the cable is led back to the drum. The turning of the drum thus causes the plane to be pulled toward the pulley—the aircraft running on the wheels of its own undercarriage and having its tail supported on a trolley which puts the machine in flying position.

When the pulley is approached, a retarding mechanism immediately releases both the cable hooks and the trolley, so that the airplane, having gained momentum with its engines running, rises into the air and flies off under its own power. The complete operation takes three seconds, which is sufficient to give an 11-ton plane a speed of 57 miles per hour before the end of the catapult is reached. In the three seconds in which the launching takes place the engine develops 3,000 hp.; and its revolutions mount from zero to 2,500 a minute in two seconds. The equipment is portable and can be carried on a motor-truck trailer.

Just how revolutionary is the land catapult can be appreciated by the fact that in less than two seconds it can develop 4,000 hp., or three times the capacity of the world's fastest automobile. And all this energy is developed in two small cylinders with mushroom-shaped heads of steel not much more than 2 feet in diameter. These cylinders are geared to the drum aforementioned. The motive power is compressed air. This is supplied by six other cylinders, giving a pressure of 600 pounds per square inch, and is delivered to the engine through a reduction valve and an expansion chamber. It is blown off through four exhausts above the engine; and, mixed with oil smoke, rises in four tall columns above the catapult.

Two pilots were in the machine during the test: they sat side by side in the great cockpit. For exactly two seconds after they had given the "ready" signal there was an inferno behind the plane. By pulling a piece of cord, a man had answered their signal and released the compressed air from the six cylinders. Then, before one could grasp what had happened, the cable was on the ground and the plane was high in the air. During those two seconds the machine had been thrown forward 100 yards and attained a speed of more than 60 miles an hour. Neither of the pilots felt the slightest shock in being thus forcibly launched.

The British Air Ministry has not yet made clear its intention concerning this land catapult; but it is obvious that it was developed to enable heavy service machines to take off from areas large enough for them to land on but not offering the length of run necessary for them to get off the ground and away under their own power.

The British Columbia Pulp & Paper Company, operating pulp plants at Woodfibre and Port Alice, B. C., has had installed what is said to be the heaviest Thorne barker so far built. This, together with an improved chipping plant, is capable of handling logs 10 feet long and 22 inches in diameter.

Rock-Dusting Makes Coal Mine Safer

DILUTE air with an inert gas and the capacity of that air to promote combustion is reduced accordingly. Similarly, if rock dust be mixed with coal dust the powdered coal is far less likely to ignite in the presence of any flame. It is upon this fact that one safety measure in gaseous coal mines is based.

As may be recalled by many of our readers, in the early "nineties" observers in Europe and in the United States noted that an explosion could be checked and even would not propagate in those parts of a mine where shale dust or some other inert dust was present in large amounts. According to a report issued by the United States Bureau of Mines: "After the disastrous Courrieres explosion in France, that killed 1,100 men, coal-dust-explosion tests were made in France in 1907 and in Great Britain in 1908. Those tests resulted in the conclusion that if enough incombustible dust were properly spread throughout passageways charged with coal dust, the propagation of an explosion by the coal dust could be prevented." Experiments made subsequently in this country by Government experts confirmed the foreign findings; and the Bureau of Mines has done its utmost since to broadcast knowledge of this means of reducing explosion hazards in gassy mines.

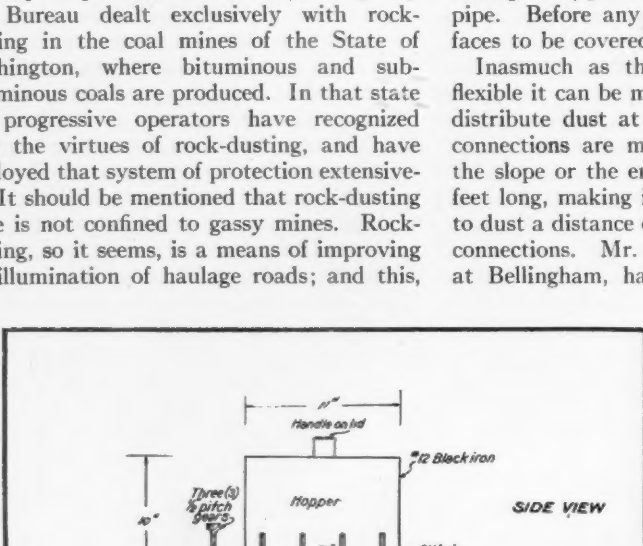
A report published about a year ago by the Bureau dealt exclusively with rock-dusting in the coal mines of the State of Washington, where bituminous and sub-bituminous coals are produced. In that state the progressive operators have recognized fully the virtues of rock-dusting, and have employed that system of protection extensively. It should be mentioned that rock-dusting there is not confined to gassy mines. Rock-dusting, so it seems, is a means of improving the illumination of haulage roads; and this, in its turn, lessens the likelihood of haulage accidents.

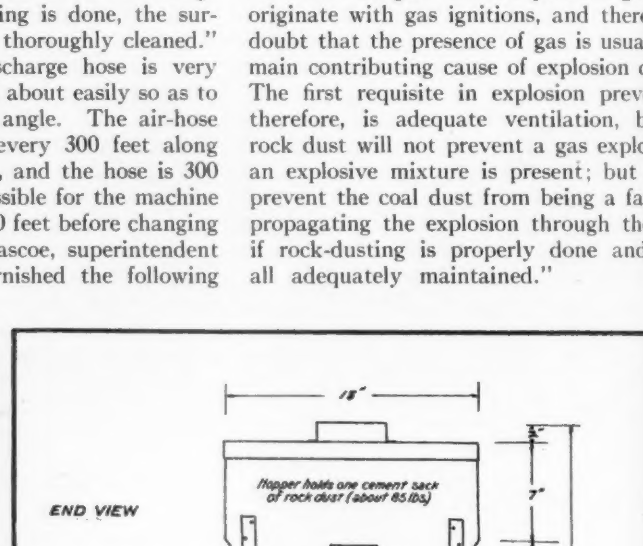
To quote from the Government report: "It is worthy of mention that the Bellingham Mine was the largest producing coal mine in western Washington during 1928. In that year the mine produced 266,673 net tons of coal and employed 212 persons underground. The Bellingham Mine is also the first in western Washington to adopt a system of rock-dusting; and as it is the largest producer its example augurs well for the future of rock-dusting in this section of the Washington coal fields. During the latter part of October, 1929, dusting near the working faces was begun in a preliminary way by the hand method. Later the dust was applied by the use of a distributing machine.

"All drilling at the Bellingham Mine is done by pneumatic drills, and for this reason compressed-air lines are carried to the faces of all the working places. Advantage was taken of this system to develop a rock-dusting machine using compressed air. The machine was designed by W. P. Williams, master mechanic, and it was built at the mine shops. It is operated by filling the hopper of the machine with dust and attaching to the compressed-air line a ¾-inch air hose which throws the dust from the hopper and discharges it against the roof, ribs, and floor through a 2½-inch flexible tube or discharge pipe. Before any dusting is done, the surfaces to be covered are thoroughly cleaned."

Inasmuch as the discharge hose is very flexible it can be moved about easily so as to distribute dust at any angle. The air-hose connections are made every 300 feet along the slope or the entries, and the hose is 300 feet long, making it possible for the machine to dust a distance of 300 feet before changing connections. Mr. J. Pascoe, superintendent at Bellingham, has furnished the following particulars: "The machine, being of light construction and mounted on Ford automobile wheels, can be moved easily by one man. Three men—one handling the discharge nozzle, one operating the machine, and one delivering dust—will cover readily and effectively in an 8-hour shift between 2,500 and 3,000 linear feet of slope or entry, 8x10 feet in cross section, and 6x6-foot cross-cuts spaced every 60 feet and extending in a distance of 30 feet. The limestone dust used is comparatively free from silica, and it is ground fine enough so that 70 per cent of it will pass through a 200-mesh screen. The dust is delivered to the mine in box-car lots of from 850 to 900 sacks to a carload—each sack weighing 85 pounds." The accompanying illustration should serve to give a fairly clear understanding of the principal features of the rock-dusting machine. Only a brief examination of the two drawings is needed to reveal the simplicity of the apparatus.

Security against explosions, so far as coal dust is concerned, depends upon the extent and the thoroughness with which the rock-dusting is done, and even then the hazard is not necessarily eliminated. Upon this point, the Bureau of Mines states: "Like all innovations, rock-dusting is sometimes thought to be a cure-all for explosions, and a mine thoroughly rock dusted is believed to be safe from that danger. Mine explosions generally originate with gas ignitions, and there is no doubt that the presence of gas is usually the main contributing cause of explosion origins. The first requisite in explosion prevention, therefore, is adequate ventilation, because rock dust will not prevent a gas explosion if an explosive mixture is present; but it will prevent the coal dust from being a factor in propagating the explosion through the mine if rock-dusting is properly done and is at all adequately maintained."

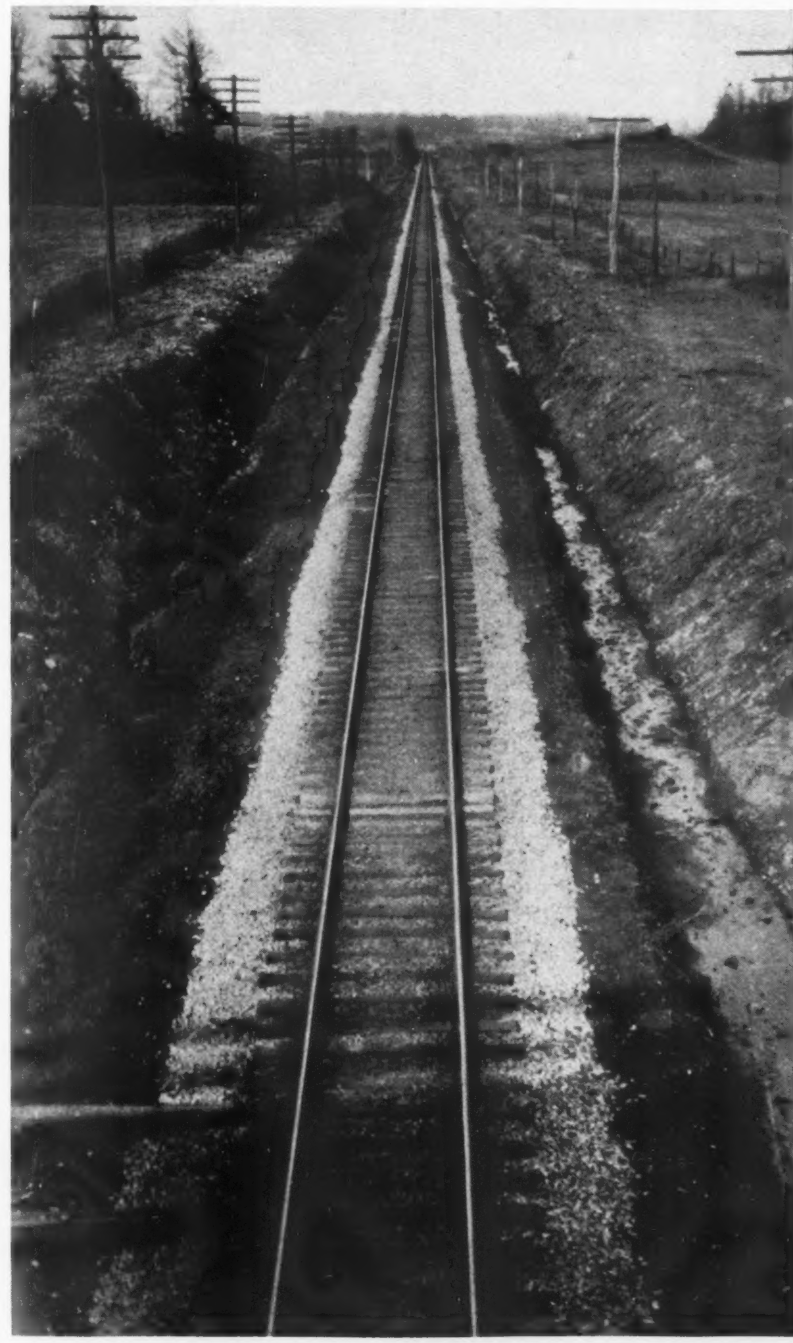




An Unfamiliar Phase of Railroad Finance

By

HOWE N. WHYE



Fine stretch of straight track on the Louisville & Nashville Railroad.

PEOPLE that travel and people that ship their commodities by rail take many things for granted. The passenger, sitting back comfortably and thinking only of his prospective timely arrival at his destination, seldom bothers himself about the money spent to speed him smoothly along on his journey. As he views it, if he consider the matter at all, of course there is a roadbed; and equally as a matter of course he concludes that that roadbed should be smooth. It is only when the train strikes a section that is not quite up to the standard that the passenger is made aware of any unevenness. Even then he does not spill over with praise because of the miles and miles of track that he has traversed without the slightest jar.

Some of the questions the traveling public and the shipper should ask are answered in the text that follows. The story is taken from the *Louisville & Nashville Employes' Magazine.* In principle, what applies to this system also may be said of all other trunk-line railroads in the United States that do their utmost to provide for the comfort and convenience of travelers and for the rapid and safe carriage of commodities entrusted to them by shippers.

The Louisville & Nashville Railroad investment in right of way and structures amounts to $302,563,133.42. Last year a total of $17,104,678.69 was spent to keep roadbed, bridges, tunnels, etc., in the necessary condition to insure the safe and comfortable movement of trains. Furthermore, $3,076,561.07 was charged to "Additions and Betterments", covering right of way and structures. This classification has to do with improvements and not with routine repairs; and the figure given for maintenance of right of way and structures is equivalent to about 6 per cent of the total investment.

Some one has asked: "What does the railroad get in return for the outlay?" And the answer is: "We get a smooth, solid, safe roadbed that we can brag about to a public which is not fully appreciative of our efforts in its behalf". Concerning the roadbed operated and maintained by the Louisville & Nashville, no one is better able to authoritatively inform us than General Roadmaster J. R. Watt. According to Mr. Watt: "Last year the Louisville & Nashville operated and maintained 5,271.98 miles of main single track, 564.31 miles of main double track, and about 2,200 miles of side track. Besides requiring a lot of money to keep up all that track and its adjacent structures, just about how many men were used in the work? We employed approximately 7,000 section laborers alone—their efforts being confined almost exclusively to track work; but in the entire Maintenance of Way Department there were in 1930 approximately 10,000 people, all of whom did their bit in spending that $20,000,000 to the best advantage".

There is a whole lot more to a railroad's right of way than one ordinarily considers: rails and fastenings, ties, ballast, switches, frogs, signals and interlocking plants, train-

Top—Group of pneumatic tie tampers at work preparatory to reballasting a track section. Circle—Stripping ballast with hand picks.

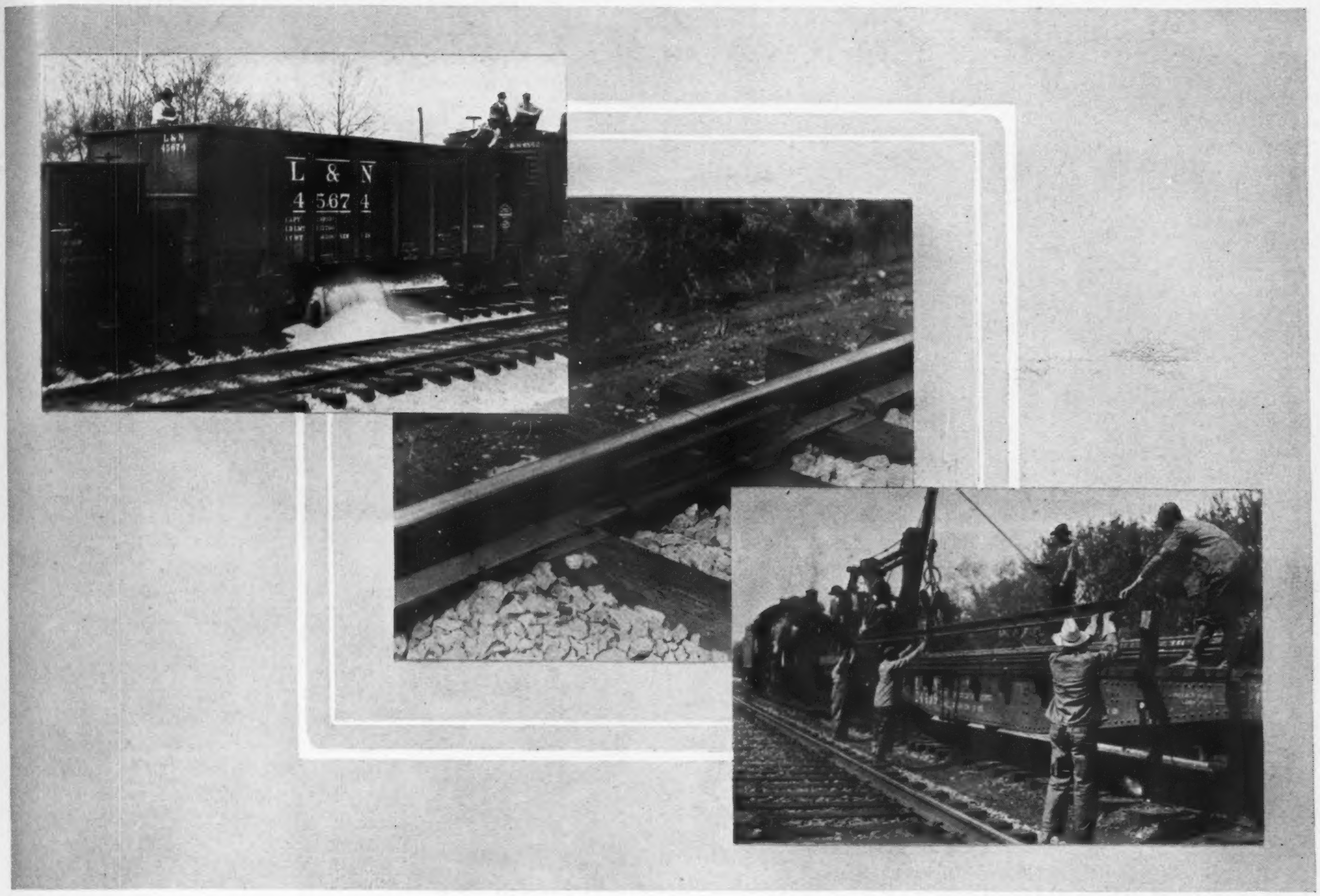
control apparatus, bridges, tunnels, land drainage, fencing, necessary buildings, etc. All these must be installed and maintained. Take rail, for instance, undoubtedly the most important detail of the track. The safety and comfort of the traveling public rests more heavily on the rails than on any other one feature of the track, therefore the Louisville & Nashville has set a high standard for its rails and makes sure that each one measures up to specifications before it is accepted. Chemical elements must be present in the proper percentages, and each rail must be free of flaws or imperfections.

After the rails are placed in the tracks they are continually watched by the section forces and promptly renewed when a defect becomes apparent. In addition to that, ever so often a detector car is employed to run over the tracks so as to find any rails that might have inner defects hidden from the eye. Of the 5,836.29 main track miles in operation last year nearly half is laid with 100-pound rail; more than half of the remainder is made up of 90-pound rail; and various other sections consist of 85-, 80-, and 70-pound rail. The character and volume of traffic determines the weight of rail required to carry it safely.

It might be of interest to know that some 836,261 tons of rail lie on the Louisville & Nashville main tracks right now, and these, at the present price of $43.25 a ton delivered, represent an investment in steel of $36,168,-288.25. Not only that, but in the past five years the road has bought on an average of 65,222 tons of new rail annually for maintenance. Yes, it takes a lot of rail to keep a good road going; but, as was said before, that is not all it takes. Every time a ton of rail is laid, about $15 worth of fastenings go along with it; and about 157 tons of 100-pound rail are required to lay one mile of single track. But we were talking about such things as rail fastenings, tie plates, spikes, bolts, lock washers, splices, and rail anchors.

Between the rail and every tie under it there is one metal tie plate to protect the tie from mechanical wear. There is a countersunk space in the plate into which the base of the rail fits, and a spike is driven in on each side holding the rail and plate securely to the tie. From four to eight anchors are used with every length of rail. They are placed against the ties and prevent the rail from "creeping" in the direction of traffic.

The splices are used in pairs, one on each side of the rails where they are joined. Each splice has four holes in it corresponding to two holes in each of the two rail ends. Through these holes the bolts are placed; and it is interesting to note that they are placed so that the head of one bolt is inside the rail while the head of the next one is outside. This is a safety feature. Should a wheel go off the rail at a joint, it would most likely shear off the nut ends of the bolts and slide



Left—Unloading ballast along the right of way. Center—This picture shows a joint after the rails have been spliced, bolted, bonded, spiked, and anchored. Right—Air-operated loader handling rails in maintenance-of-way work.

off the head ends without damage, leaving two bolts to hold the rails together.

And what of the crossties? We learn from Mr. Watt that about 2,800 crossties are needed for each mile of single track. The Louisville & Nashville 1930 bill for crosstie maintenance was a matter of $2,381,834.94. There are about 16,500,000 ties under the main-track rails of the system; but if all the trackage of the Louisville & Nashville is considered the number mounts to 21,000,000. The ties are of red oak, sap pine, white oak, and cypress—the first two being seasoned for a year or more and treated with creosote oil, and the last two being used unseasoned and untreated. Ties for main-track service are known as No. 4 and No. 5. The No. 4 tie is 7x8 inches by 8½ feet, while the No. 5 is an inch wider.

Climate and traffic conditions determine the size and kind of ties to be used on the various parts of the line. Cypress, for instance, will not withstand the rigors of a freezing climate; but down where the weather is mild the cypress tie is highly satisfactory. No cypress ties are used north of Montgomery. On the southern divisions, under normal conditions, their average life is about fifteen years, which is about as good as any of them do. In 1930, a treated tie cost $1.70; cypress, $1.30; and white oak, $1.10. At that, of the 1,507,149 crossties laid by the Louisville & Nashville last year, 1,293,870 were of the creosoted variety. Incidentally, the Louisville & Nashville was one of the first roads in the United States to employ creosoted ties.

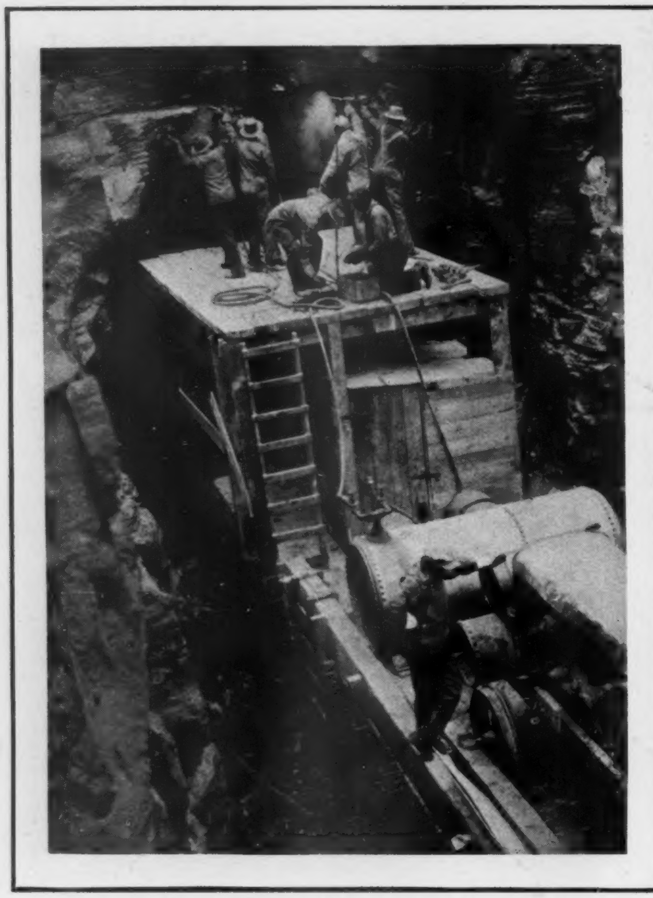
So much for ties. Next in line in the formation of the roadbed is ballast. This is no mean item, considering that ballast maintenance cost the company $362,000 in 1930. It is the business of the ballast to hold the track solidly and firmly in place. Such mediums as rock, slag, gravel, and chatt are used to ballast the main track—track conditions and the available supply determining the selection. The lines south of Nashville are ballasted entirely with furnace slag, much of which comes from the copper mines at Copper Hill, Tenn.; elsewhere all but the St. Louis Division, which makes use of chatt, are ballasted mainly with rock; and cinders for the most part serve as ballast in the yards.

Reballasting a section of track is an interesting operation that has to be done on an average of once every two or three years. The pressure of traffic on the rails would eventually—if not watched continually—cause the track to settle slightly, producing an uneven surface that might jostle the passengers. Before this happens the track is resurfaced, that is, the old ballast is tamped under the ties, the track is raised a couple of inches, and new ballast is added between and around the ends of the ties. By making adjustments here and there along the rail at points determined by sighting, a new and smooth surface is obtained. Such a ballasting operation requires about 600 cubic yards of ballast per mile.

The right of way that has so far been discussed has been distinguished by the absence of complicated physical characteristics—just plain, straight track. However, very little right of way is like that. Last year a sum of $1,500,000 was spent for what is known as "Other Track Material", including the thousand or more switches and frogs renewed, a large number of guard rails and clamps, and various other items such as rail fastenings. It should be mentioned here that in the Louisville & Nashville network of tracks there are more than 15,000 "turnouts". If you are not familiar with road-department terms, a turnout is the complete assembly of all the parts of what the layman thinks of when he says "switch".

And then there are signals and interlocking plants in which the company has invested $5,230,604.40 and on which nearly $500,000 was expended for maintenance in 1930. Such things are part of modern railroad operation and greatly facilitate the safe handling of traffic. On December 31, 1930, a total of 1,589.98 miles of the road was protected by automatic block signals. There are 3,204 semaphore signals and 93 signals of the color-light type. Also worthy of mention is the fact that $388,714.64 has been spent in installing a system of automatic train control on the Knoxville and New Orleans divisions.

Other familiar and costly characteristics of the Louisville & Nashville's steel highway



Gang equipped with air tools scaling tunnel on the Memphis line.

are the bridges and the tunnels. More than $500,000 went for new bridges, and in excess of $750,000 for their maintenance. But bridges there must be; and they are built of timber or steel according to the needs. If all these bridges were placed end to end they would extend for a distance of more than 100 miles; and of this length 40 miles constitutes steel construction.

If one were to traverse every mile of the Louisville & Nashville right of way one would pass through 118 tunnels with a total length of 18.54 miles. One might notice that for a stretch of about nine miles they are concrete lined; that for a little more than six miles they are driven through solid rock and are unlined; that for slightly less than two miles they are brick lined; and that they are reinforced with timber for approximately a mile and a quarter of the way. It is rather surprising, in view of the enormous figures dealt with, to find that tunnel maintenance in 1930 cost the comparatively small sum of $31,157.06.

It should not be overlooked that the railroad, before it could lay the track which cost all that money, had to have something to lay it on. It had to acquire land for right of way, some of which it had to buy, as evidenced by an outlay of $318,308.86 for that purpose last year. Much of this land had to be graded and fenced; and the fencing has to be maintained. It should be understood, however, that the Louisville & Nashville does not have to build nor to maintain all the fencing along its line, but it is responsible for a goodly portion of it. It is considered better to pay for fences than to permit people's livestock to wander at will on the right of way. Just like everything else, that goes into the make-up of a roadway. The fencing material must conform to Louisville & Nashville standards. Both woven and barbed wire are used; and posts are of black locust or juniper, concrete, and steel, and are spaced 20 feet apart. It is estimated that about three-fourths of the system's right of way is fenced on both sides. And last, but not least, $21,849.81 was expended in 1930 for removing snow and ice from the right of way. According to General Roadmaster Watt, 1930 was about the lightest year he could recall in that respect.

Of course, the different phases of track and roadway maintenance are not all done by hand and small tools. The Louisville & Nashville has thousands of dollars invested in mechanical devices such as tie-tamping machines, rail-laying machines, spreaders, ditchers, etc., and each year repairs and depreciation on them add their weight to the aggregate cost.

The foregoing particulars are only some of the outstanding phases of maintenance-of-way work on an up-to-date railroad, but they will serve the present purpose, which is to bring home to the average person some of the big outlays and the ceaseless attention that must be devoted to keeping the roadbed and its appurtenant features in a condition that will assure the public the service it expects.

ARTIFICIAL CONCRETE AGGREGATE LIGHT IN WEIGHT

GLOBULITE is the trade name of a lightweight aggregate that is being manufactured by a special process invented by Knox Harding of Los Angeles, Calif. The aggregate is made of ordinary brick clay to which is added a small quantity of granular carbonaceous material. This mixture is forced through a multiple die, whence it issues in the form of numerous round pugs. These pugs are sliced into thousands of small billets which, while still plastic, are passed through a machine that turns them into balls and at the same time coats them with a refractory material, such as fire clay. The globules next enter a 6x62-foot rotary kiln in which they are subjected to a temperature high enough to fuse the basic material but below the fusing point of the refractory coating. As a result of this heat treatment, which takes 21 minutes, the original volume of each ball is increased anywhere from four to seven times.

BUTTON HOLE TAPE A CONVENIENT FORM OF PACKING

ASBESTOS tape as a gasket material has been used for many years and, as far as the material itself is concerned, has fulfilled with satisfaction the work for which it was designed. But in the form in which it has generally been supplied the tape has not always been easy to apply, as, for instance, in the case of locomotive front ends and flanged tanks of large diameter. This difficulty, however, has now been overcome by the so-called "Button Hole Tape", on which The Garlock Packing Company has applied for a patent.

The new tape packing is made up of two parallel courses of high-grade, folded asbestos cloth joined by a single ply of bonding fabric. As shipped from the factory the tape has no holes. These are made at the point of use by inserting a knife blade between the two strips and cutting the bonding material. Any workman can thus quickly make a succession of button holes spaced on any desired center, and apply the tape by slipping the bolts or studs through them. The resulting gasket will remain in place, lie flat, and form a positive seal around every bolt. Ordinarily, the holes are slit as the tape is used in order to obviate errors in measurements and possible wastage. However, as there may be occasions when it is preferable to do this work at a bench, the tape comes marked with 1-inch graduations to serve as guides in cutting.

To complete a gasket, the makers recommend bringing the two ends together by a step joint which should be wrapped with friction tape, a roll of which is supplied with every box of packing. Garlock 616 Button Hole Tape is manufactured in coils of any desired length and in all regular widths and thicknesses.

Applying Button Hole Tape to the flange of a tank.

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